Evaluating the usability of Web-based Learning Management Systems

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ABSTRACT

A great number of Learning Management Systems (LMSs), commercial or open source exists nowadays (e.g. WebCT, Blackboard, IBM LearningSpace, etc.) offering integrated services such as the creation and distribution of on-line learning material, the communication between stakeholders, the management of the instruction process etc., thus providing the basic software platform for supporting web-based learning in an easy-to-use, and pedagogically flexible manner. This paper proposes a framework on the analysis of potentiality and on the evaluation of LMSs' admissibility. The most commonly used LMSs have been selected for the application of this specific framework. The aim of the evaluation is twofold; to search their usefulness and their quality in use.

Introduction

Networked technology has and will continue to have a profound impact on education around the globe. It holds significant potential in advancing the interactivity between learners and tutors, in offering flexibility for the means of learning, and in providing easy, one-stop maintenance and reusability of resources (Lowe and Hall, 1999; Nielsen, 1995). However, the educational community has much to learn regarding how and in which ways technology can enhance the instructional process. While there is a large amount of related literature devoted to research on the impact of technology in education, there is much that we don't know about its effectiveness (Institute for Higher Education Policy, 1999).

The new and innovative technology infrastructure in the area of education are Learning Management Systems (LMSs), hypermedia environments that provide an integrated platform for online learning by enabling the management, delivery and tracking of mixed learning (i.e., online and traditional classroom). A great number of LMSs exist nowadays (e.g. WebCT, Blackboard, LearningSpace, Centra, TopClass) providing integrated services such as the creation and distribution of on-line learning material, the communication and collaboration between the stakeholders, the management of instructional systems and so forth, thus providing the basic software platform for supporting web-based learning in an easy-to-use, pedagogically flexible and cost-efficient manner (IEEE LTSC, 2000). These systems offer a uniform interface to learners, tutors, learning material authors, instructional designers and administrators, and promote portability of learning resources as well as interoperability between each other. LMSs have been widely used for educational and training purposes not only

because they have been advertised as the state of the art learning technology, but also because they:

- Alleviate the constraints of time and place of learning,
- Provide an excellent degree of flexibility concerning the way of learning,
- Support advanced interactivity between tutors and learners, and
- Grant one-stop maintenance and reusability of resources.

The plethora of LMSs available today, in conjunction with the varying needs of instructors and institutions, creates a need for investigating the potential and appropriateness of LMSs. Such systems offer different services and capabilities regarding organization and distribution of learning content, course management, student assessment, communication and collaboration tools, administration of instructional institutions and so forth. There has to be some comparative analysis and assessment of LMSs, which clearly probes their features in the context of pedagogy, open learning and instructional design. Consequently instructional designers that are called upon to solve a specific instructional problem with explicit needs and requirements will be assisted in choosing a specific LMS that fits closer to their problem.

A number of comparative reviews are available on the World Wide Web. To our knowledge, the most important are:

- [http://www.edutools.info/course/index.jsp], a comprehensive presentation of technical characteristics of LMSs and an on-line tool for the automatic comparison of systems, based on certain criteria.
- [http://www.leeds.ac.uk/educol/documents/00001237.htm], a review that provides a full framework for the evaluation of LMSs based on pedagogy and system organization, applied on 12 systems.

- [http://www.esocrates.com/LearningResources/ComparisonChart.htm]
- [http://www.eun.org/goto.cfm?did=22819], an LMS check list for Schools produced by the European Schoolnet.

These reviews present tables of features supported by selected LMSs. They usually focus on the mere presentation of the features supported by the LMSs being examined, as well as on the comparison between them according to specific criteria. An evaluation model is often introduced, based on technical and pedagogical principles.

The focus of this research is to present some first findings of yet another evaluation study which attempts to analyze the usability and acceptability of contemporary learning technology systems. However, the proposed evaluation study suggests a two step process: a) to explore the utility of LMSs and consequently discover the real nature of these systems based on the features they support; and b) to delve into the usability of LMSs, a critical factor in the acceptance of these systems by the market.

The structure of this paper is as follows: In section 2 we provide a categorization framework for Learning Management Systems. In section 3 we describe in detail the model used for the evaluation of such systems. Section 4 presents the qualitative results from a short evaluation study where the aforementioned model was applied, while section 5 continues with some conclusions deduced from the study.

Learning Management Systems

LMSs have been widely adopted by institutions and instructional designers in order to fulfill certain needs and requirements for effective, fast and pedagogically correct education and training. Consequently, the people involved in the decision-

making process concerning instructional design and organization of educational institutions would use an LMS in order to:

- Create, operate and administrate an on-line course.
- Support the collaboration between students and provide motivation and resources for team building (McConnell, 1994).
- Create and deliver questions and tests for student assessment.
- Organize educational, financial and human resources.
- Administer virtual, distributed classes where the students are geographically scattered and communicate via the Internet.

These diverse usage scenarios of LMSs, correspond to different categories of Learning Technology Systems, which are respectively the following:

- General systems, which have a number of tools for creating and managing courses and do not emphasize to any particular set of features. We call these systems ‘general’ and not, for example ‘Course Management’, because they provide a plethora of features that span many assorted areas, in order to provide fully functional on-line courses, such as communication tools, administration tools, etc.
- Collaborative learning support systems, which emphasize on team building, student group management and provide the synchronous and asynchronous collaboration tools to support the aforementioned activities.
- Question and test authoring and management systems, which facilitate the design and construction of quizzes and tests that are published on the Web and served on-line. They provide tools for test creation and their on-line delivery, automatic grading, results manipulation and report generation.

- People and institute resources management systems, which deal with human resources and financial management.
- Virtual classrooms, which establish a virtual space for live interaction between all the participants in the learning process, i.e. instructors, tutors and students.

The LMSs that fit in one of the above categories support a number of features, tools and capabilities in order to carry out certain tasks. These features do not discretely belong to only one LMS category but can be shared by several categories. These features can be classified into certain groups, namely:

- Course management, which contains features for the creation, customization, administration and monitoring of courses.
- Class management, which contains features for user management, team building, projects assignments etc.
- Communication tools, which contains features for synchronous and asynchronous communication such as e-mail, chat, discussion forums, audio/video-conferencing, announcements and synchronous collaborative facilities (desktop, file and application sharing, whiteboard).
- Student tools, which provide features to support students into managing and studying the learning resources, such as private and public annotations, highlights, bookmarks, off-line studying, log of personal history, search engines etc.
- Content management, which provides features for content authoring and delivery and file management.
- Assessment tools, which provide features for managing on-line quizzes and tests, project deliverables, self-assessment exercises and so on.

- School management, which provides features for managing records, absences, grades, student registrations, financial administration etc.

Tables 1 and 2 contain lists that represent well-known commercial and open source LMS platforms currently in use, especially in institutions of higher education.

¯Insert Table 1 here¯

¯Insert Table 2 here¯

The large numbers of LMSs as well as the varied needs of teachers and institutions generate the need of a thorough research for their characteristic pedagogical features in open learning and usability educational designing (instructional design). These evaluations usually focus in a simple comparative presentation of characteristic features that are been supported by the LMS, as well as in the comparison between them.

This paper proposes a new approach in the evaluation of LMS that not only focuses in functional characteristics, but mainly in usability issues, during their use in the educational process. The significance criterion "high pedagogic operation performance" is imported for a LMS, which is a different criterion from that of "high technical operation performance". Also, the significance of "subjective satisfaction of users from their contact with the system" is differentiated. There are not only examined subjects of aesthetics but also preferences of satisfaction and educational objectives per type of user (instructor and learner).

It is not enough to cognize that the operation "Addition of Educational Material" is functional from an operational point of view (following one of the formal methods of usability evaluation). This operation should be functional from a pedagogical viewpoint also. For example, when a teacher adds files with important material for the learners an automatic briefing should inform the educated (if such information through the LMS has been selected to be given). This functional specification - which is a usability specification - is connected with a requirement from the pedagogical approach of the learner, who wants to inform his students for the material that he distributes and which concern concrete educational activities (Gagne et al., 1994). Formal usability differentiation from functional and pedagogic viewpoint is "web discussion forum" (asynchronous discussion sessions). It is likely that such a tool provided by an LMS (e.g. the WebCT) has high usability significance according to Nielsen's criteria. However, when a user replies to a message of another user, the latter won't be informed. In that way, notification of users, does not occur, while an electronic message could be sent (e.g. e-mail digest). Keeping the educated aware for what happens in an asynchronous discussion is very important in order to increase its effectiveness (Sgouropoulou, 2000).

The evaluation model

Frame of evaluation of acceptance of LMSs

LMSs should be regarded as complex hypertext systems having a rich navigation structure in order to present the learning content and tools that they provide. The intricacy of hypermedia applications has become common knowledge and there are

various techniques and models used in order to manage this structural and semantic complexity (Squires & Preece, 1999; Lowe & Hall, 1999).

Thus, having adapted the hypertext usability criteria, proposed in (Nielsen, 1993; Nielsen, 2000), to this evaluation model we aim, first of all, to address the *acceptability* issue, which incorporates the *practical acceptability* (costs, platform dependency, utility, usability, etc.) and the *educational acceptability* (if it fits well with the instructional goals and philosophy of the owner). Figure 1 illustrates the whole evaluation model.

¯Insert Figure 1 here¯

Most of the criteria in the "practical acceptability" group can be easily checked. However, the "usefulness" criterion should be further analyzed since it is also related to the "educational acceptability" criterion. Thus the scope of this paper is to further elaborate on the usefulness criterion.

By using the proposed evaluation model, we aim at two goals: a) to discover what an LMS does, i.e. which features it supports and b) to classify the LMS into the appropriate category. The first goal can be achieved by providing tables of features and ticking the suitable check box, that indicates the support for a specific feature for every LMS. The second goal can be accomplished by identifying the groups of features that an LMS supports and by deciding about which one of the LMS categories it better fits into. This decision should not be taken in an ad hoc manner, but according to the mapping of Table 3. This mapping portrays the relation between the aforementioned Learning Technology Systems categories and the groups of features that we have selected in order to characterize the LMSs.

The classification of LMSs under evaluation into categories is of paramount importance, as it seeks to shed some light into the real nature of these systems, about which there is currently much confusion. The terms used to describe the LMSs are covered by much vagueness and fuzziness and companies or other development organizations tend to assert these systems with expressions that further augment the uncertainty. There is surely no common vocabulary that characterizes the LMSs, which results in hindering the building of consensus among various stakeholders. Our approach tries to clarify things by characterizing LMSs objectively, according to the features they support. An important issue that must be emphasized here is that it is possible for a LMS to fit into more than one category, i.e. it can be used for more than one purposes.

¯Insert Table 3 here¯

Having said all that, we reach to the point that the evaluation model so far has dealt with the utility of the LMSs by proposing the identification of features that each LMS supports, and the classification of the LMSs into the defined categories. The second part of the model deals with the usability of the LMSs, which is not concerned about *which* features are supported by each LMS, but *how well* they are supported. This approach is based on the hypertext usability criteria proposed in (Nielsen, 1993; Nielsen 2000), takes into account the evaluation principles suggested in (Tessmer, 1996) and elaborates on the above in order to set usability criteria especially for LMSs.

While the utility criterion concerns the examination of the features that an LMS supports, the usability criterion covers the quality of the support facilities. Thus it deals with the following issues:

1) Easy to learn and comprehend. The users of an LMS must easily comprehend the system and learn how to use it. This concerns the navigation, the selection of tools and functions and the metaphors. It is also important that special technical skills are not a pre-requisite.
2) Efficient in feature realization. LMSs are designed to perform certain tasks, but it is obvious that not all LMSs perform the same tasks in the same manner (e.g. the video conferencing facility in CUSEEME and Microsoft Netmeeting). The question here is how well the various tasks are being performed.
3) Efficient in navigation. Users who navigate through the hypermedia structure of an LMS must at all times know where they are and why they are there, where they came from and where they can go from there.
4) Forgiveness from errors. Users of an LMS often navigate back and forth through various paths, due to an inclination to experimenting and exploration. A forgiving system allows users to return quickly and easily to the point where they started through commands such as "undo", "back", "revert" etc.
5) Pleasant to use. An LMS must have pleasant aesthetics, which is the result of the color code in use, the graphics and animation quality, the fonts etc. An LMS is also pleasant to use when the downloading and the transition between pages of content are fast, or in other words when the user is not forced into frustrating delays.

One way to measure the usability of a LMS according to the proposed model we used is to ask users to perform specific tasks that correspond to the functionality scenarios in real time. After interacting with the system we ask them to mention their opinion about each LMS using the above criteria. When questionnaires are used we ask them to grade the LMSs using a scale from 1 to 5 (where a small number means poor

performance and a large one means good performance). This sort of usability evaluation is performed for each category of potential users, namely the students, the designers, the tutors and the administrators. This is important because different categories of users are provided with different kind of features, and even the features that are shared by more than one user categories have different user interfaces.

Application phases for the evaluation frame of acceptance of a LMS

The proposed frame of evaluation of acceptance of LMSs can be applied only from experts. There are two phases of the application:

- Preparatory phase. In this phase, a definition of the features that are supported by the under evaluation LMS, is produced along with a table that is being created with them, categorized in groups such as those that have already been mentioned before (course management, self-assessment, etc). It is proposed that the evaluators should mark the significance of usability importance of each one of the characteristics. The significance (in three gradations: Very important, Important, Neutral) is determined by LMSs pedagogical utilisation. For example, if a LMS is used for the evaluation of students through deliveries, the equivalent operation should be characterized as very important.
- Phase of implementation where it involves two aims a) to discover what a LMS can offer, that is to say which characteristics it supports and flowingly to categorize it in the suitable category and b) to clarify how many of these characteristics are well supported. Thus e.g. if we are interested if the addition of an announcement tool into a LMS in order for it to provide the possibility to dispatch a message via electronic post (or via SMS) to the registered users and

simultaneously add this statement in the "News board" of the specific course but also in the "News board" from all the related to the student courses (case of operation of “myLMS”). The experts examine the operations that the LMS supports and after they check their completeness; they are focused in how well the particular operations are supported.

A Case study

We have applied this evaluation model in practice twice: once for 16 open source LMSs and then for 13 commercial LMSs. The criteria for selecting the specific systems out of the entirety of the LMSs in the market are: a) the degree of adoption they have received by instructional institutions and b) the availability of resources for our evaluation (on-line documentation, white papers and demonstration versions of the systems). We concluded in the 16 and 13 LMSs respectively that appear in Tables 1 and 2, which we consider being the most widely adopted in the educational market and that also offer adequate resources for their evaluation.

It is reminded that we consider a group of criteria to be supported by an LMS if the majority of features in the group are also supported. Taking into account the mapping between the categories of LMSs and the groups of Features, as shown in Table 3, we classify the systems in the categories defined in Section 2. Our analysis was focused towards the “General” category systems, since such LMSs support the majority of the features mentioned. We only tested systems from the “General” category because of the wide adoption of this category and the extensive hypertext user interface that characterizes them. The results are shown in Tables 1.and 2

As far as the usability evaluation is concerned, about the proprietary systems we evaluate, we used the criteria described in the previous section to test three of the most dominant systems of the 'General' category: WebCT, Blackboard and VirtualU. We applied our criteria for two types of users: Students (St), Instructors and Designers (ID).

Three (3) highly experienced in usability evaluation issues of LMSs users and developers, participated in the study of this evaluation. We asked them to act as students and then as designers. After elaborating with the systems we asked them to pinpoint their opinion about each LMS using the usability criteria. The results of the evaluation are represented in Table 4. Each evaluator examined the LMSs, without contacting with his colleagues, using the proposed frame of evaluation. When this thorough individualised evaluation research was completed a meeting with the attendance of all experts took place, in which opinions were exchanged and discussion were been held about all their findings.

¯Insert Table 4 here¯

Concerning the usability evaluation of the open source systems, we examined 16 of the most adopted systems. Two evaluation experts using the criteria previously described, after a thorough analysis, reached the conclusion of choosing two of the specific LMSs which seemed to be the most dominant. These systems were Jones e-education V2003 and Moodle 1.1.

The criteria have been applied for 2 types of users: students, instructors and designers. Our evaluation was double faced. Firstly we enumerated all the supported features and gave emphasis on the usability aspect. This is a good metric for the potential of LMSs but cannot be an inclusive measure for the comparative analysis and

evaluation of web-based Learning Management Systems. The results of the evaluation are represented in Table 5.

¯Insert Table 5 here¯

As this evaluation comparison concludes, both systems are very well featured especially in usability issues. Actually the outcome from our scrupulous analysis was that although these systems are open source (that means without any costs for those interested using them for educational purposes), they compete in quality with the proprietary LMSs. Another practical outcome was that our department decided to use Moodle instead of Jones e-education mostly because it has been translated into the Greek language.

Conclusions

The mere enumeration of supported features is a good metric for the potential of LMSs, but cannot be an inclusive measure for the comparative analysis and evaluation of web-based Learning Technology Systems (Avouris, 2001; Paternò, 2000; Grigoriadou & Papanikolaou, 2000). The proposed model has two aspects: i) the classification of the LMSs into categories according to specific objectives, and ii) the survey of the usability of these systems. The first aspect aims at clarifying the real disposition of a LMS under evaluation, as there is currently little insight concerning what each of these systems actually represents, what it is able to perform, and what needs it can cover. The second aspect deals with an often-overlooked matter, the usability of the hypertext user interface, which is rather critical in LMSs that are extensively based on human-computer interaction.

Even if this study aimed to evaluate the most well developed open source LMS, useful conclusions had been drawn. Indeed the evaluation study was simple and mainly aimed to test and validate the proposed model. It had limitations, such as: 1) only experts participated to the evaluation process; it would be better if we could use learners, as well, 2) the evaluation study didn't run in a real educational environment, but it was actually a laboratory test. From the tables 1, 2 and 4 it is obvious that the most full featured and powerful commercial systems are Blackboard and WebCT, while from the open source category Jones e-education V2003 and Moodle 1.1. It is not a surprise that these systems are the most popular in the education and training arena at present.

The future directions of our research deals with a) a more extended evaluation study with more users, b) with the development of tool for facilitating the collection and analysis of the participants' feedback, and c) the development of design patterns for Learning Management Systems.

Design patterns originate in the work of the architect Christopher Alexander. They have been adopted in software engineering and are now flowing into other areas, such as educational design. A pattern 'describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice' (Alexander, 1977). Patterns are all about reusability, which seems to be the keyword in achieving the economies of scale for building affordable software systems. Reuse in the form of analysis, design, or architectural patterns, is even more important than simple code reuse.

Design patterns for the evaluation of the LMSs have already been published (Avgeriou et al. 2003a, Avgeriou et al. 2003b) and a special interest group has been formed to share and develop design patterns regarding LMSs, laying the foundations for a pattern language for such systems, called “E-LEN: a European network of e-learning centres” [http://www.tisip.no/ELEN]. This group aims, except from other, in the production of a bank of design patterns regarding to the various aspects of electronic learning. The idea of use the design patterns for evaluation, already has been successfully applied for systems of electronic trade (Sartzetaki et al 2003) since their use decreases by far the time for preparation of evaluation and offers explicit directives for what it means functionality for a specific operation. The basic concern is to find the design patterns and manage do become widely acceptable, so they can also be developed for the usability evaluation with main imperative to create a design pattern language for LMSs.

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References

Alexander, C., Ishikawa, S. and Silverstein, M. (1977), A Pattern Language: Towns, Buildings, Construction, Oxford University Press.

Avgeriou, P., Papasalouros, A., Retalis, S. and Skordalakis, E. (2003), "Towards a Pattern Language for Learning Management Systems", Educational Technology & Society, ISSN 1436-4522, 6(2) pp. 11-24, ISSN 1436-4522.

Avgeriou, P., Papasalouros A. and Retalis, S. (2003), "Patterns For Designing Learning Management Systems", Proceedings of the European Pattern Languages of Programming (EuroPLOP) 25th-29th June 2003, Irsee, Germany.

Avouris, N. M., Tselios, N., and Tatakis, E. C. (2001), Development and Evaluation of a Computer-based Laboratory teaching tool, Journal of Computer Applications in Engineering Education, 9(1), pp 8-19.

Gagné, R., Briggs, L., & Wager, L. (1994), Principles of Instructional Design, Fort Worth, TX: HBJ College Publishers

Grigoriadou, M. and Papanikolaou, K.A. (2000), Learning Environments on the Web: The Pedagogical Role of the Educational Material. Themes in Education, 1(2), 145-161.

IEEE Learning Technology Standards Committee (2000), "Draft Standard for Learning Technology Systems Architecture (LMSA)", November 2000.

Lowe, D. and Hall, W. (1999), Hypermedia & the Web: An Engineering Approach, John Wiley & Sons Ltd.

McConnell, D. (1994), Implementing Computer Supported Cooperative Learning, Kogan Page, 1994.

Nielsen, J. (1993), Usability Engineering, Academic Press, London.

Nielsen, J. (2000), Designing Web Usability: The Practice of Simplicity, New Riders Publishing, Indianapolis.

Paternò, F. (2000), Model-Based Design and Evaluation of Interactive Application. Springer Verlag, ISBN 1-85233-155-0.

Sartzetaki, M., Psaromiligkos, Y., Retalis, S. and Avgeriou, P. (2003), Usability evaluation of e-commerce sites based on design patterns and heuristic criteria, Proceedings of the 10th International Conference on Human - Computer Interaction, Heraklion Crete, June 22-27, 2003.

Sgouropoulou, C., Koutoumanos, A., Goodyear P. and Skordalakis E. (2000), Acquiring Working Knowledge through Asynchronous Multimedia Conferencing, Educational Technology & Society 3(3), ISSN 1 436 -4522.

Squires, D. and Preece, J. (1999), Predicting quality in educational software: Evaluating for learning, usability and the synergy between them, Interacting with Computers, 11, pp. 467-483.

Tessmer, M. (1996), Formative Multimedia Evaluation, Training Research Journal, vol. 1, pp. 127-149.

Table 1. The most familiar commercial systems in the education and training market, categopration results

Name	Company	URL
General		
WebCT	University of British Columbia	http://www.webct.com
CoSE	Staffordshire University	http://www.staffs.ac.uk/COSE
Centra	Centra Software	http://www.centra.com
Cate	Cate	http://www.cate.com
Convene	Convene	http://www.convene.com
LearningSpace	Lotus	http://www.lotus.com/home.nsf/welcome/learnspace/
BlackBoard	Blackboard	http://www.blackboard.com
TopClass	WBT Systems	http://www.wbtsystems.com
VirtualU	Virtual Learning Environments	http://www.vlei.com
FirstClass (Zebu)	Centrinity	http://www.firstclass.com
Intralearn	Intralearn	http://www.intralearn.com

Table 2. The most familiar open source systems in the education and training field, categorization results

Name	Company	URL
General		
ATutor 1.3	University of Toronto (ATRC)	http://www.atutor.ca
Bazaar 7	University of Athabaska	http://klaatu.pc.athabascau.ca/cgi-bin/b7/main.pl?rid=1
Bodington	University of Leeds	http://bodington.org/bodington/opensite/
CHEF	University of Michigan	http://chefproject.org/index.htm
Claroline 1.4	Claroline Development Community	http://www.claroline.net/
ClassWeb 2.0	Social Sciences Computing, UCLA	http://classweb.ucla.edu/
CourseWork	Stanford University	http://getcoursework.stanford.edu/
Eledge 3.1	Chuck Wright	http://eledge.sourceforge.net/
Fle3	UIAH Media Lab, Univ of Art and Design Helsinki	http://fle3.uiah.fi/
Jones e-education V2003	Jones Knowledge, Inc.	http://www.jonesknowledge.com
KEWL 1.2	University of Western Cape	http://kewl.uwc.ac.za/
LON-CAPA 1.0	LITE Lab, College of Natural Science, Michigan State University	http://www.lon-capa.org/
Manhattan Virtual Classroom 2.1	Western New England College	http://manhattan.sourceforge.net/
MimerDesk 1.5.3.1	Ionstream Ltd	http://www.mimerdesk.org/
Moodle 1.1	Moodle.com	http://moodle.org
Whiteboard 1.0.2	Todd Templeton	http://whiteboard.sourceforge.net/
dotLRN	MIT	http://dotlrn.mit.edu/

Figure 1. The criteria of the evaluation model

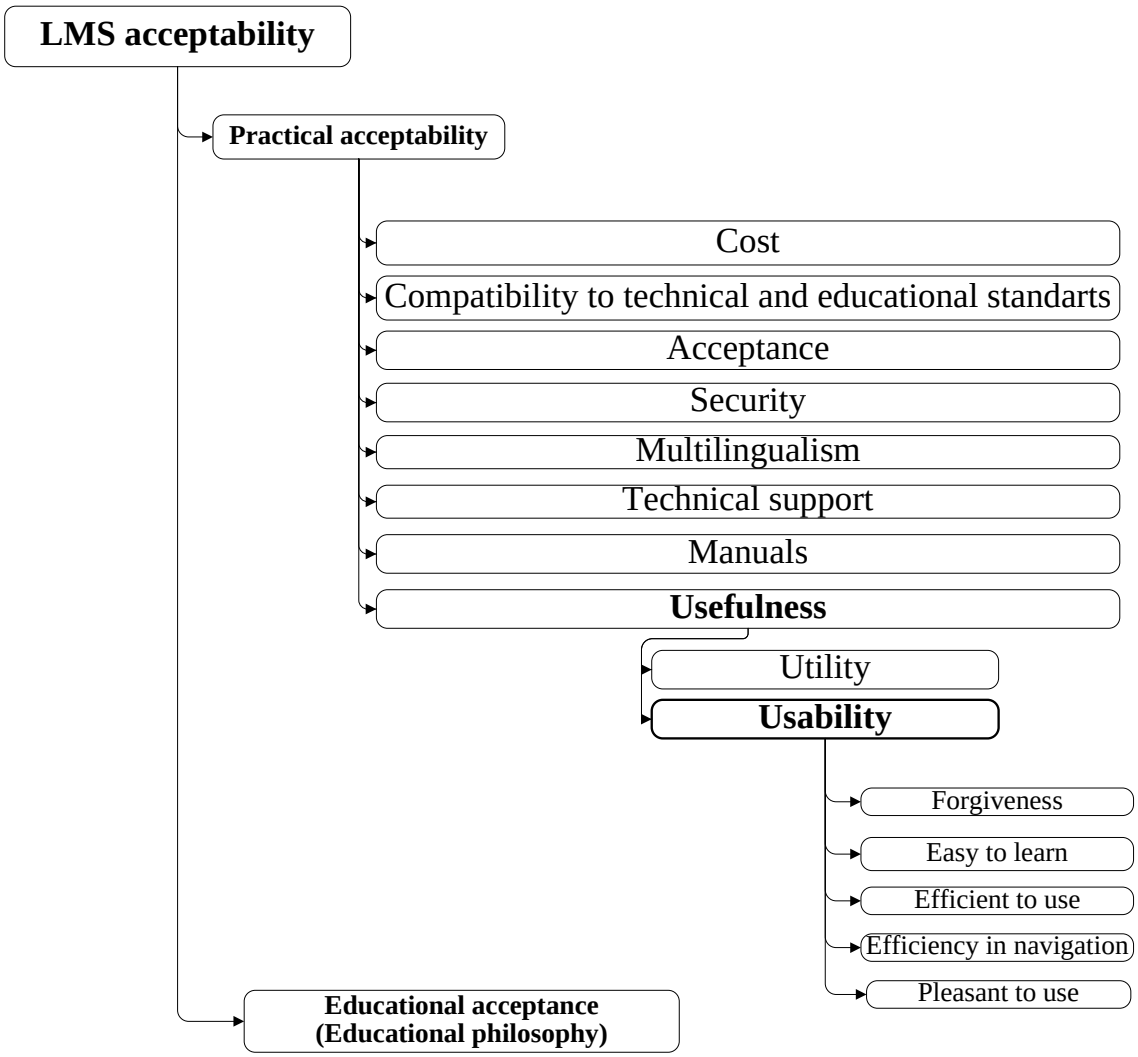

Table 3: Mapping between LMS categories and groups of features

LMS CATEGORIES SUPPORTED GROUPS OF FEATURES	General Systems	Collaborative Learning Support Systems	Virtual Classrooms	Question and Test Authoring & Management Systems	People and Institute Resources Management Systems
Course Management	X				X
Class Management	X	X	X		X
Communication Tools	X	X	X		
Student Tools	X	X	X	X	
Content Management	X			X	X
Assessment Tools	X			X	
School-Management	X				X

Table 4: Proprietary Systems Usability Assessment per User

LMS	Usability Criteria									
	Easy to learn and comprehend		Efficient in feature realization		Efficient in navigation		Forgiveness from errors		Pleasant to use	
	St	ID	St	ID	St	ID	St	ID	St	ID
WebCT	5	4	4	5	5	4	3	2	5	4
Blackboard	5	5	4	4	5	4	4	3	4	4
VirtualU	3	3	2	2	3	3	2	2	4	3

Table 5: Features of open source Learning Management Systems

LTS ACCEPTABILITY	Jones e-education	Moodle
1. PRACTICAL ACCEPTABILITY		
1.1 Cost	The license under which the software is available for free to qualifying post-secondary institutions provides the source code and permits the modification of the source code for internal purposes. The license does not permit any derived works or re-distribution and the title and copyright of the source code are retained by the product provider.	The software is free and distributed under the GNU Public License. The product provider will install the software for a fee.
1.2 Compatibility to standards	Compliance with Section 508 of the US Rehabilitation Act for students	To comply with Section 508 of the US Rehabilitation Act, the software implements the following features: alt tags on all system images, and data tables that are optimized for use with screen readers.
1.3 Acceptance	Residing in 57 countries around the globe	911 sites from 70 countries have registered.
1.4 Security	Administrators can protect access to individual courses with a username and password. User logins can be encrypted with SSL. Passwords stored in the system database are encrypted. Administrators can assign different levels of access to the system or courses based on the following pre-defined roles: instructors, teaching assistants, students, guests, administrators, system administrators, client administrators. Administrators can customize existing roles.	The system uses basic username and password authentication. The system can authenticate against a variety of sources, including external databases, LDAP directory servers, IMAP, POP3 and secure NNTP servers. The software provides tools for Administrators to assign access privileges to different group roles: Administrators, Instructors, Students and Guests. Group role privileges can be further defined into subgroup privileges.
1.5 Multilingualism	Only in English	34 language translations are available as plug-in packs
1.6 Technical support	Instructors can access the online instructor guide, help, and the product user group. Instructors can contact the 24/7 technical support helpdesk by email, a toll-free phone number, or voice mail.	Instructors can access the online instructor manual, context sensitive help, and an instructor support community hosted on the product provider's site.
1.7 Manuals	The system includes an online course, which can be customized or replaced by the institution, to help students learn how to use the system. The top right corner of each software page has a "Help" icon.	Students can access context sensitive help.
1.8 Usefulness		
1.8.1 Utility	Excellent	Very good
1.8.2 Usability		
1.8.2.1 Forgiveness	very good	very good
1.8.2.2 Easy to learn	very good	very good
1.8.2.3 Efficient to use	very good	very good
1.8.2.4 Efficiency in navigation	very good	very good
1.8.2.5 Pleasant to use	very good	very good