Evaluation Models for E-Learning Platform: an AHP approach

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Abstract - **Our "information-oriented" society shows an increasing exigency of life-long learning. In such framework, the E-Learning approach is becoming an important tool to allow the flexibility and quality requested by such a kind of learning process. In the recent past, a great number of on-line platforms have been introduced on the market showing different characteristics and services. With a plethora of E-Learning providers and solutions available in the market, there is a new kind of problem faced by organizations consisting in the selection of the most suitable E-Learning suite. This paper proposes a model for describing, characterizing and selecting E-Learning platform. The E-Learning solution selection is a multiple criteria decision-making problem that needs to be addressed objectively taking into consideration the relative weights of the criteria for any organization. We formulate the quoted multi criteria problem as a decision hierarchy to be solved using the Analythic Hierarchy Process (AHP). In this paper we will show the general evaluation strategy and some obtained results using our model to evaluate some existing commercial platforms.**

Index Terms – E-Learning, E-Learning Platform, Multiple Criteria Decision Making Problem

INTRODUCTION

The whole world is undergoing a change that maybe is the most important one in the last thirty years, and, through the spreading of new information technologies, is deeply modifying relations among countries, markets, people and culture. The technological revolution has clearly promoted a globalization process (nowadays Internet represents the global village) and information exchange.

Information can be considered as an economical value whose significance is closely associated with the knowledge that it offers. Updated knowledge is a fundamental and decisive aspect of professions related to the New Economy but the new society's dynamism does not well adapt itself to past training models developed in more static or slowly changeable contexts [1]. The continuous need of new knowledge and competences has really shattered this boundary and professional people have to qualify themselves and to be willing to acquire new knowledge.

So new didactic models have arisen. In this scenario one of the most promising approaches is the E-Learning approach. Several enabling factors played key role in today developments, including, among the other, the wide acceptance of the concept of Learning Objects, the availability of several E-Learning platforms and the diffusion of standards, like SCORM, to improve interoperability. Evaluation of E-Learning platforms requires evaluating not only the implementing software package, but additional features as well, including, among the others the supported teaching and delivering schema, the provided QOS and so on. With respect to this question, both pedagogical and technological aspects must be carefully evaluated. In the first case, it is necessary to develop new training models clearly defining how to organize new training paths and the didactic contents associated with them, as well as how to provide these contents in relation to the user who benefits from them. As for the technological aspect, new tools for distributing knowledge must be created, tools able to reproduce as efficiently as possible pedagogical training models. In fact, a series of features should be taken into account when one evaluates E-Learning platforms, starting from the function and usability of the overall learning system in the context of the human, social and cultural organization within which it is to be used. Obviously, the analysis of the features of a system is not sufficient: it is also important to understand how they are integrated to facilitate learning and training and what principles are applied to guide the way the system is used. To evaluate them both pedagogical and technological aspects must be carefully evaluated.

So the goal of this paper is to show a model for selecting the most suitable E-Learning solution taking into account its technological and pedagogical aspects. In literature there are many approaches to the E-Learning platform [3]. A common approach is the introduction of some evaluation grids able to evaluate the various aspects of an E-Learning platform. The weak point of this approach is in the subjectiveness of the judgements. The starting point of the proposed model is the formulation of a multi criteria decision problem to be solved by the Analytic Hierarchy Process (AHP).

The hierarchical structure of the problem allows the decision maker to compare various features that characterize E-Learning platforms. The Analytical Hierarchy Process (AHP) is a decision-aiding method developed by Saaty [2-5]. It aims at quantifying relative priorities for a given set of alternatives on a ratio scale, based on the judgment of the decision-maker, and stresses the importance of the intuitive judgments of a decision-maker as well as the consistency of the comparison of alternatives in the decision-making process. Since a decision-maker bases judgments on knowledge and experience, then makes decisions accordingly, the AHP approach agrees well with the behaviour of a decision-maker. The strength of this approach is that it organizes tangible and intangible factors in a systematic way, and provides a structured yet relatively simple solution to the decision-making problems [6]. So the real aim of this paper is to introduce the application of the AHP in E-Learning Platform Evaluation.

The paper will briefly review the concepts and applications of E-Learning platform and of the multiple criteria decision analysis, the AHP's implementation steps. Finally we the obtained results applying the proposed approach on some existing commercial and Open Source E-Learning platforms.

E-LEARNING PLATFORMS

In our opinion the most part of contemporary E-Learning platform can be viewed as organized into three fundamental macro components: a Learning Management System (LMS), a Learning Content Management System (LCMS) and a Set of Tools for distributing training contents and for providing interaction [7].

The LMS integrates all the aspects for managing on-line teaching activities. The LCMS offers services that allow managing contents while paying particular attention to their creation, importation and exportation. The set of tools represents all the services that manage teaching processes and interactions among users. In the following, after describing in detail the characteristics of the LCMS, LMS, and Set of Tools, technological and pedagogical requisites for a distance learning application will be defined, in order to outline an evaluation model. A Learning Content Management System includes all the functions enabling creation, description, importation or exportation of contents as well as their reuse and sharing. Contents are generally organized into independent containers, called *learning objects*, able to satisfy one or more didactic goals.

An advanced LCMS must be able to store interactions between the user and each learning object, aiming at gathering detailed information about their utilization and efficacy. The importance of LCMS is related to the growing distance learning request that is determining a significant increase in content production. The current effort is to avoid a useless duplication of contents by realizing learning objects consonant to given standards in order to reuse them in different contexts and platforms. The trend towards a growing of training resources, though necessary to better characterize the training process, does not allow the teacher an easy consultation and use of these ones. At the same time, such an important number of resources can disorientate students that may run the risk of not choosing, during the auto-training phase, the contents more suitable to them. A solution to this problem is given by a more detailed description for each content so as to avoid ambiguity or duplication among them. In particular, some information will support the content so as to better identify the domain in which resources are included and to draw LCMS and teacher's attention to the most peculiar characteristics of the training content. In literature, this descriptive process is known as metadata description. At present, the scientific community and industries engaged in this field are trying to define standard metadata rules, so as to encourage understanding of the real semantic content of the various training resources. Therefore, the aim is not only to facilitate and automate research and training resource acquisition over the web, but also to find the contents that better satisfy the student training needs.

The Learning Management System (LMS) embraces all the services for managing on-line teaching activities. In particular, it aims to offer management functionality to training platform users: system administrators, teachers and students. From students' point of view, a LMS must offer services able to evaluate and report the acquired skills storing the training path followed by them. A LMS should give the teacher the possibility of verifying the right formulation of the various lessons and suggesting changes (in case it is semi-automatically inferred from student tracking) in the learning path. Therefore, the functionalities of a LMS integrated within a distance learning platform can be synthesized as follows: Student management, Course management, Student skill assessment, Student activity monitoring and tracking, Activity reporting.

A student management system integrated within a LMS must manage a database containing standardized descriptions of student data so as to better identify the user and his/her characteristics. This type of description is generally based on the XML meta-language (Extensible Markup Language), an element that guarantees data portability. When we talk about portability, we refer to the possibility of accessing a resource, in this case, the students' descriptions, independently of the computer type and operating system. This characteristic is necessary for an E-Learning platform that aims to be compatible with a high number of hardware platforms, operating systems and standard applications. Standardized descriptions of users can be then used within the platform to store personal data, training profiles and the most significant events characterizing their learning path. On-line training efficiency is directly related to the tools made available by the delivery platform as well as to their usage easiness. The services should satisfy teacher and student needs and it is therefore necessary that the same kinds of services are different in accordance with the user. In particular, teachers should be provided with tools enabling them to manage teaching processes for single individuals or groups, as well as all the interactions, including asynchronous discussions or live events. In addition, it is important to provide the teacher with updated reports on learner or learner groups' progresses so as to better manage evaluation processes and facilitate activities.

Besides, it is necessary to give students the possibility of synchronously and asynchronously communicating with both the teacher and other students. For example, the Virtual Classroom Service is a service designed for distributing courses in a synchronous mode, and also for supporting on-line live teaching. This type of service aims to reproduce the mechanisms present in a classroom during a traditional training session and is considered as a kind of container in which all the services able to recreate a virtual classroom atmosphere will be included. The use of a virtual classroom is obviously foreseen during "live" lessons in order to better manage synchronous interactions. Other synchronous services are audio and video conference, chat, whiteboard. So the evaluation will be carried out by comparing the platforms on the basis of the parameters introduced in this paragraph.

THE MULTIPLE CRITERIA DECISION ANALYSIS AND THE AHP APPROACH

The selection of an E-Learning platform is not a trivial or easy process. Project managers are faced with decision environments and problems in projects that are complex. The elements of the problems are numerous, and the inter-relationships among the elements are extremely complicated. Relationships between elements of a problem may be highly nonlinear; changes in the elements may not be related by simple proportionality. Multiple criteria decision-making (MCDM) approaches are major parts of decision theory and analysis. They seek to take explicit account of more than one criterion in supporting the decision process [8].

The aim of MCDM methods is to help decision-makers learn about the problems they face, to learn about their own and other parties' personal value systems, to learn about organizational values and objectives, and through exploring these in the context of the problem to guide them in identifying a preferred course of action. In other words, MCDM is useful in circumstances which necessitate the consideration of different courses of action, which can not be evaluated by the measurement of a simple, single dimension [8]. A good solution for the MCDM problem is in the AHP approach. After a long period of debate, in fact, on the effective value of the AHP approach Harker and Vargas [9] and Perez [10] proved that the AHP approach is based upon a firm theoretical foundation.

The AHP approach is composed by the following steps:

1. Define the problem and determine its goal.
2. Structure the hierarchy from the top (the objectives from a decision-maker's viewpoint) through the intermediate levels (criteria on which subsequent levels depend) to the lowest level which usually contains the list of alternatives.
3. Construct a set of pair-wise comparison matrices (size NxN) for each of the lower levels with one matrix for each element in the level immediately above by using the relative scale measurement shown in Table 1. The pair-wise comparisons are done in terms of which element dominates the other.
4. There are n(n-1) judgments required to develop the set of matrices in step 3. Reciprocals are automatically assigned in each pair-wise comparison.
5. Hierarchical synthesis is now used to weight the eigenvectors by the weights of the criteria and the sum is taken over all weighted eigenvector entries corresponding to those in the next lower level of the hierarchy.
6. Having made all the pair-wise comparisons, the consistency is determined by using the eigenvalue, λ_{max}, to calculate the consistency index, CI as follows: $CI = (\lambda_{max} - n)/(n-1)$ where n is the matrix size. Judgment consistency can be checked by taking the consistency ratio (CR) of CI with the appropriate value in Table 2. The CR is acceptable, if it does not exceed 0.10. If it is more, the judgment matrix is inconsistent. To obtain a consistent matrix, judgments should be reviewed and improved.
7. Steps 3-6 are performed for all levels in the hierarchy.

Numerical rating	Verbal judgments of preferences
9	Extremely preferred
8	Very strongly to extremely
7	Very strongly preferred
6	Strongly to very strongly
5	Strongly preferred
4	Moderately to strongly
3	Moderately preferred
2	Equally to moderately
1	Equally preferred

Table 1 Pair-wise comparison scale for AHP preferences

Size of matrix	1	2	3	4	5	6	7	8	9	10
Random Consistency	0	0	0.58	0.09	1.12	1.24	1.32	1.41	1.45	1.49

Table 2 Average random consistency (RI)

THE AHP APPROACH AND THE SELECTION OF AN E-LEARNING PLATFORM

E-Learning platforms have to satisfy some rules in order to be effective and, besides, some platforms can be really effective only in some well defined scenario. Obviously this is a Multiple Criteria Decision Problem. So the first step is to set the interest scenarios; in this paper we consider the following cases: An ECDL course, a blended university course, a professional training course. In the following paragraphs we will describe in more details the selected scenarios. So now the first step is the definition of the AHP hierarchy. Obviously in this case the first level is the selection of the best E-Learning platform for the selected scenario. The second level is composed by features that have in account pedagogical, technological and usability aspects. In particular we have introduced five main features:

- Management
- Collaborative Approach
- Management and enjoyment of interactive learning objects
- Usability
- Adaptation of learning path

Obviously every feature involves, in their determination, some sub-features. In order to test our approach we selected four E-Learning platforms: a commercial solution Docent and three solutions developed or by academic structure IWT and Achab or by an open source organization Running Platform. Docent is a fully web based E-Learning platform.

Docent [13] is composed by: a LMS: the offered services allow the management of the activities of students. In particular these services track the activities of students, manage assessment phases, and check the milestones of curriculum. A LCMS: It is composed by a Learning Content management tool and a producer tool. Docent support the “de facto” metadata standards for learning objects, user profiles and courses description. Tools: Docent offers many tools for synchronous and asynchronous interaction among students, teachers and learning objects.

IWT [14] is an E-Learning platform developed by the MOMA group. IWT platform has many tools for the management of users, contents and courses. The platform is developed by the use of Microsoft .NET framework. The main features offered by IWT are the management of the course ontology, the full compatibility with the main E-Learning standards. IWT offers many tools for synchronous and asynchronous interaction among students, teachers and learning objects.

Achab [15] is a web-based E-Learning platform developed by the DYNELAB of University of Salerno. Achab has some tools for the users, courses and learning object management.

The last one analyzed platform is Running Platform. It is customized by the L3 group [16]. This platform aims to support the activities of traditional courses. In fact it has many asynchronous tools and few synchronous tools. It is complaint with the most important E-Learning standard. Now we can describe in details the proposed approach for the various scenarios. We have to outline that the various scenarios are obtained from the analysis of real cases. In particular we have considered scenarios that are in our University.

The first involves the selection of an E-Learning platform for the endowment of ECDL courses. In this case the platform has to support classes composed by thirty students. These students are not really familiar with computers’ world. So the usability feature has to be highly and carefully evaluated. In this scenario it is very important the tracking of the progress of the students. Another characteristic of this user group is the not very wide internet connection bandwidth.

The second scenario describes a typical situation: E-Learning platform has to support the activities of some courses. So in this scenario management tools are very important. Also the collaborative tools have to be considered.

The last scenario involves the use of an E-Learning platform in the case of professional training. In this case the target group is not very skilled on ICT technologies and needs to interact with very simple and clear graphic user interfaces. In this case the usability feature has a really importance. Also the tools for the adaptation of learning path are important because the target group could be very heterogeneous. So according to the AHP approach we have to compare the various platforms each other for every feature and scenario. First of all we have to declare the standing of the features ordered by importance.

For the various scenarios we have the following standing (Table 3):

ECDL Course	Blended Course	Professional Training
Management	Management	Usability
Management and enjoyment of interactive learning objects	Management and enjoyment of interactive learning objects	Adaptation of learning path
Usability	Collaborative Approach	Management and enjoyment of interactive learning objects
Adaptation of learning path	Usability	Management
Collaborative Approach	Adaptation of learning path	Collaborative Approach

Table 3: Standing of considered features ordered by importance for the considered scenarios

After this phase in order to have a value for every feature we considered some evaluation grids introduced in [8] in order to evaluate the following indexes:

Management Index

Management Index = IM = Obtained Value for the supported tools / Max Value

This index aims to evaluate how many services for the management of students and of their progress are in the various platforms. In the table 4 we show the obtained results. In this table the column Weight indicates the relative importance of the feature.

Tool	Weight	IWT	ACHAB	DOCENT	RUNNING PLATFORM
Progress Tracking	3	3	3	3	3
Course Management	2	2	2	2	2
Groups management	2	0	2	2	2
Contents Management	1	1	1	1	1
Contents Sharing	2	2	0	2	2
Import Standard Contents	1	1	0	1	0
Import Contents	2	2	2	2	2
New Courses Management	1	1	1	1	1
Course Index	1	1	1	1	1
Report	2	2	0	2	0
Assessment	1	1	1	1	1
Courses Catalogue	1	1	1	1	1
Multiple Question Test	1	1	1	1	1
Assessment Report	2	2	2	2	2

On-Line Registration	1	1	0	1	1
User Management	1	1	1	1	1
Total	24	22	18	24	21
IFG		0,917	0,750	1	0,875

Table 4: Obtained results for the Management Index

Collaborative Index

IC = Obtained Value for the supported tools / Max Value

This index aims to evaluate how many "collaborative" services are in the various platforms. With the term "collaborative" services we intend these platform services allowing the interaction among students and/or teachers. In the table 5 we show the obtained results. In this table the column Weight indicates the relative importance of the feature.

Tool	Weight	IWT	ACHAB	DOCENT	RUNNING PLATFORM
E-Mail	1	1	1	1	0.5
Forum	2	2	2	2	2
Chat	2	2	2	2	2
WhiteBoard	2	2	1	2	1
Streaming A/V	2	2	0	2	0
Contents Download	2	2	2	2	2
Application Sharing	2	2	0	2	0
Virtual Classroom	3	3	0	3	0
Total	16	16	8	16	7..5
IC index		1	0,5	1	0,469

Table 5: Obtained results for the Management Index.

Management and enjoyment of interactive learning objects

MIO = Obtained Value for the supported tools / Max Value

This index aims to evaluate how many services for the management and enjoyment of interactive learning objects are in the various platforms. In the table 6 we show the obtained results. In this table the column Weight indicates the relative importance of the feature.

Tool	Weight	IWT	ACHAB	DOCENT	RUNNING PLATFORM
Streaming A/V	2	2	0	2	0
Contents Download	2	2	2	2	2
Application Sharing	2	2	0	2	0
Virtual Classroom	3	3	0	3	0
Total	9	9	2	9	2
MIO Index		1	0,222	1	0,222

Table 6: Obtained results for the management and enjoyment of interactive learning objects

Usability

For the usability feature we used a questionnaire introduced by Nielsen [11]. The aim is to evaluate the use easiness of the platforms and of their interfaces. The obtained results are in the table 7:

IWT	ACHAB	DOCENT	RUNNING PLATFORM
0,866	1	0,866	1

Table 7: Usability value of various platforms

Adaptation of users formative learning path Index

LPA = Obtained Value for the supported tools / Max Value

This index aims to evaluate how many services for the adaption of users formative learning path are in the various platforms. These services have to allow the creation of personalized learning paths and the continue assessment of students. In the table 8 we show the obtained results. In this table the column Weight indicates the relative importance of the feature.

Tool	Weight	IWT	ACHAB	DOCENT	RUNNING PLATFORM
Progress Tracking	3	3	3	3	3
User Groups management	2	0	2	2	2
Report	2	2	0	2	0
Assessment	1	1	1	1	1
Multiple Question Test	1	1	1	1	1
Assessment Report	2	2	2	2	2
Total	11	9	9	11	9
LPA Index		0,818	0,818	1	0,818

Table 8: Obtained results for the adaptation of users formative learning path index

At the end of this phase we can compare the "relative" obtained results of platforms in every feature in order to have a standing. According to the AHP approach we defined the "absolute" weight of every feature keeping in mind the constraints of the selected scenario. According to the AHP strategy we can compose the results in the following way:

$$\text{Platform Final Score} = \sum_{i=1,..,5} Weight_i * PlatformValue_i$$

The final results are depicted in Figure 1.

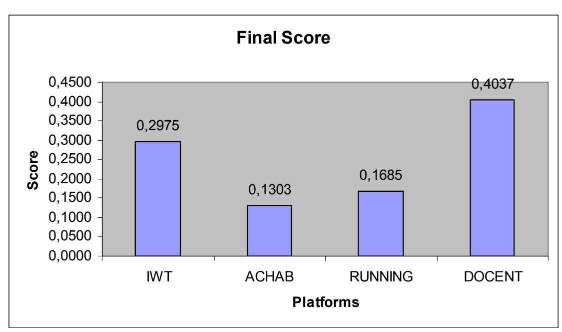

Figure 1: Obtained Results for the ECDL scenario

We extended our approach to the other scenarios obtaining the following results (Figure 2 and 3).

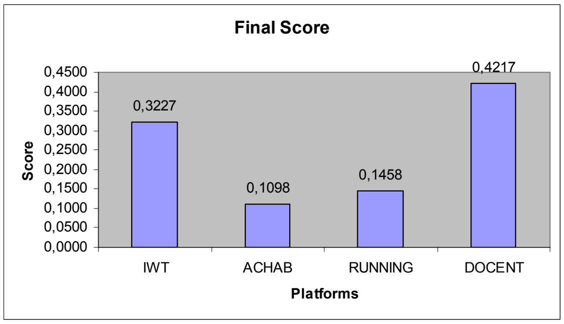

Figure 2: Obtained Results for the blended course scenario

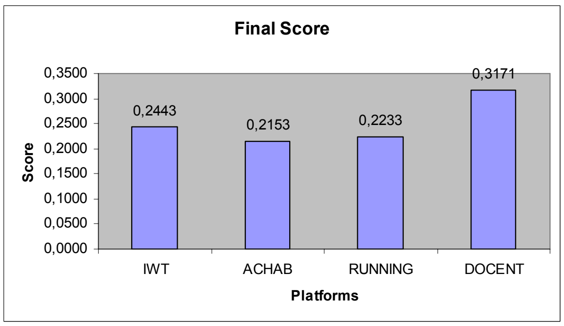

Figure 3: Obtained Results for the blended course scenario

So we can say that the AHP approach allows not only to evaluate the platforms but to test them application in a well defined scenario. In fact Docent platform has very good results in the first two scenarios while in the third it is not true. In fact in the third case all the management or collaborative tools are not very important. The obtained results confirm that the difference between commercial platforms and open source in general is still very high, but our method shows as in some scenarios this is not true. In this it can suggest the use of a cheaper platform.

CONCLUSIONS

In order to accurately evaluate the potentialities of an online learning platform, it is important to pay attention to its three main components: Learning Management System, Learning Content Management System and Virtual environment for teaching and services associated with it. An efficient system must be able to integrate into oneself all these components so that they can efficaciously interact with each other.

Besides, it is necessary that such platforms make reporting data services available, so as to allow accurate analyses on activities carried out by users. One of the most interesting problem is the introduction of a general and objective model for the evaluation of E-Learning platforms. This task is not trivial because a good evaluation model has to take in account not only the platform and its services but also the scenario where it has to work. So in this paper we have introduced an evaluation model based on the use of AHP approach.

The AHP approach, in fact, is useful in circumstances which necessitate the consideration of different courses of action, which can not be evaluated by the measurement of a simple, single dimension. In this way we can evaluate an E-Learning platform considering both its application in the interest scenario, both its comparison with other considered platforms. We tested our approach on four E-Learning platforms and in three scenarios. The obtained results are encouraging and effective. The proposed method, in fact, do not only evaluate the platform but also its effectiveness in the considered scenario. In this paper, for example, we showed as in some scenario the performances of a commercial platform as Docent are similar to the ones of "academic" frameworks. We aim to extend the proposed approach to new scenarios and platforms.

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