

# EVALUATION OF E-LEARNING TOOLS BASED ON A MULTI-CRITERIA DECISION MAKING

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**Abstract:** This paper shows a benchmarking of different e-learning tools based on the definition of a set of criteria which are useful and desirable characteristics of learning management systems. The final results show the evaluation from different perspectives. The evaluation is carried out using a methodology based on such set of criteria as well as a mixture of Multi-Criteria Decision Making methods to evaluate different modern technologies applied in training and e-learning systems. The criteria are grouped in a three-dimensional model in accordance with their use and application in training processes. The proposed model organises the set of criteria in three axes according to their functional scope, the Management, the Technological and the Instructional axes. Applying this methodology we evaluated different learning technologies and then we compare them from different points of view. The objective of this work is to help e-learning users and developers make good decisions about which tools have the best features for developing a system for management of resources, courses and learning objects.

## 1 INTRODUCTION

The aim of this work is to present the outcomes of a benchmarking of e-learning technologies which is based on a proposed evaluation methodology within a three-dimensional (3D) model of criteria. The information, the evaluation methodology and the 3D model of criteria might provide useful information to e-learning users and developers to make good decisions about which tool has or should have the best features for choosing or developing a management system of instructional resources such as courses and learning objects. The three-dimensional (3D) model and the proposed methodology in this paper, not only are helpful to evaluate the applicability of each learning tool from a global point of view, but they are also useful to establish the ranking of each learning tool in every dimension (axis): Management (M), Technological (T) and Instructional (I), in every plane (MT, MI, TI) and in a 3-dimensional space (MTI). This provides different viewpoints which allow evaluating each tool; these perspectives help to determine whether or not a tool fulfils the requirements from a Management, Technological or Instructional point of view.

Although the extant literature has many articles, books, internet services, and guides to evaluate LMS packages (Brandon 2006, Edutools 2007) they do not use the approach presented in this paper, and where there is some similarity, the method is not described in detail as it is covered here. The evaluation methodology described here is easy to implement using office tools and it can be adapted to evaluate other software products as database management systems and virtual reality development environments (Islas et al., 2004).

A huge number of LMS packages are available; more than 100 are mentioned in (Brandon 2009). The proposed methodology was used to evaluate only three commercial platforms (Blackboard, IBM Lotus and PeopleSoft) and five open source tools (Docebo, Dokeos, Joomla, Moodle and Sakai) since these LMS are extensively used. We believe that this evaluation might be useful for companies to make a decision about which tool fulfil their requirements to use in their e-learning and e-training activities (Horton and Norton, 2003).

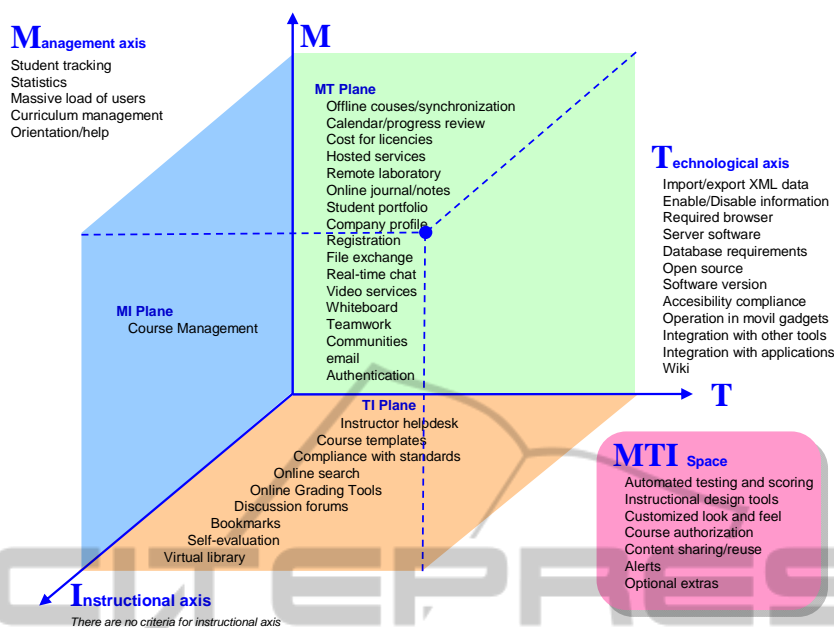


Figure 1: Three-dimensional model to evaluate modern learning and training systems.

## 2 EVALUATION METHODOLOGY

### 2.1 Three-Dimensional Model

The model we are proposing in this work is being used in our research group to analyze modern learning and training systems. This model relates the three more important aspects involved in personnel training and that constitutes the 3 axes of the 3D model, namely: Management, Technological and Instructional. Different analysis, evaluations or studies can be made with the 3D model proposed. Every point in the model (see Fig 1) will fall in one of the axes, in a plane or in the space of the 3D coordinate system and would represent an eligible capacity to be evaluated, observed or monitored.

### 2.2 Criteria and Weight Definition

The methodology is based on 50 criteria used to evaluate different technologies applied in modern training and learning systems. This evaluation methodology, personalized with an appropriate set of criteria, has been applied earlier in the evaluation of software and hardware tools, which are related with development of virtual reality systems (Pérez et al., 2003). The criteria for e-learning tools are grouped in the 3D model described above in accordance with their use and application in training and learning processes.

### 2.3 Evaluation Methods Definition

The objective for applying three amalgamation Multi-Criteria Decision Making (MCDM) methods is to compare the weighting methods and value functions in terms of their ease of use, appropriateness and validity (Bell et al., 1998), (Chankong and Haimes, 1983), (Hobbs and Meier, 1994) and (Stewart, 1992).

**MCDM 1.** Additive value function and non-hierarchical weight assessment.

$$MAX V(A_j) = \sum_{i=1}^n w_i v_i(x_{ij}) \quad (1)$$

where:

$x_{ij}$  The value of criterion  $x_i$  for alternative  $A_j$

$v_i(x_{ij})$  A single criterion value function that converts the criterion into a measure of value or worth. These are often scaled from 0 to 1, with 1 being better. In this first method these values were not scaled

Weight for criterion  $x_i$ , representing its relative importance. These are often normalized then:

$$\sum_{i=1}^n w_i = 1$$

$w_i$  In this first method the weights were not normalized, instead they all were assigned with the same value of 1

$n$  Number of criteria

**MCDM 2.** Additive value function and hierarchical weight assessment.

$$MAX V(A_j) = \sum_{i=1}^n w_i v_i(x_{ij}) \quad (2)$$

where:

In this second method these values were scaled from 0 to 1 using the following expression:

$$v_i(x_{ij}) = 1 + \frac{5-x_{ij}}{-5}$$

$w_i$  In this second method the hierarchical weight assessment was used

The MAX in (1) and (2) indicates that higher values are better.

**MCDM 3.** Goal programming and hierarchical weight assessment.

Goal programming focuses on achievement of goals, as oppose to additive value functions, which emphasize trading off criteria.

$$MIN V(A_j) = \sum_{i=1}^n [w_i |g_i - v_i(x_{ij})|]^p \quad (3)$$

where:

$v_i(x_{ij})$  In this third method these values were scaled from 0 to 1

$w_i$  Also in this third method the hierarchical weight assessment was used

The goal for criteria  $x_i$ , defined as acceptable, desirable or ideal. In goal programming,

$g_i$   $v_i(x_{ij})$  are usually linear functions of  $x_{ij}$

$p$  Exponent applied to the absolute value of the weighted difference between the goal and the actual value. In this third method was used  $p=1$ , which is often called "city block" metric

MIN in (3) indicates that smaller values are better.

**3.3 LMSs Evaluation Results**

The following section shows the results obtained applying the three amalgamation methods described above. The systems evaluated were: Blackboard v9.0, Docebo v4.0, Dokeos v2.0, IBM Lotus v8.5.3, Joomla v2.5, Moodle v1.9.9+, PeopleSoft v9.0 and Sakai v2.8.

**3.3.1 Results Obtained**

The results for the first MCDM method are depicted in Fig 2, which shows the ranking and global results for each software tool. These global results include all the criteria considered applying the additive value function without scaling the value function  $V_i(X_{ij})$  and using non-hierarchical weight assessment. In this method, the best evaluated tool was Moodle followed by Blackboard.

In Fig 3 the results obtained for the second

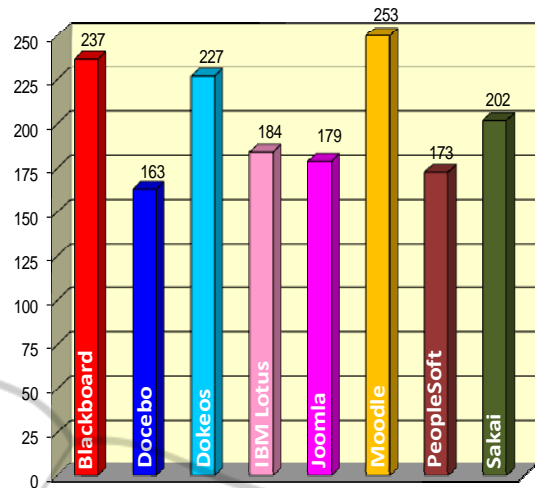


Figure 2: Total results obtained applying the first MCDM method for the systems evaluated.

MCDM method are shown applying the additive value function with the scaling of the value functions from 0 to 1 and using hierarchical weight assessment. In the first and second method greater values mean better e-learning tools. In this case as in the former the best tools considering all the characteristics was Moodle and Blackboard.

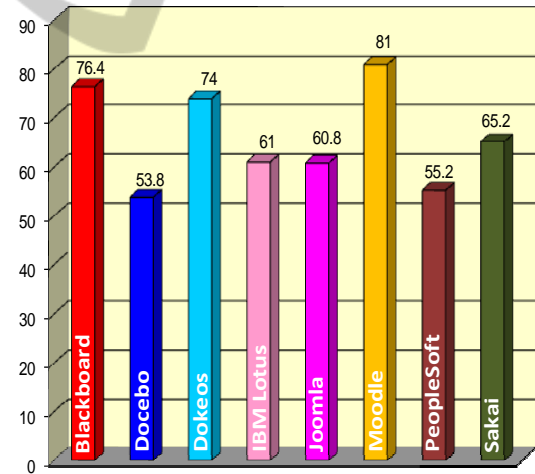


Figure 3: Total results obtained applying the second MCDM method.

Finally in Fig 4 the results obtained for the third MCDM method are shown, in this third amalgamation method we applied goal programming and hierarchical weight assessment, in this method smaller values mean which e-learning tools are better. Also in this evaluation, Moodle and Blackboard were selected as the best LMSs.

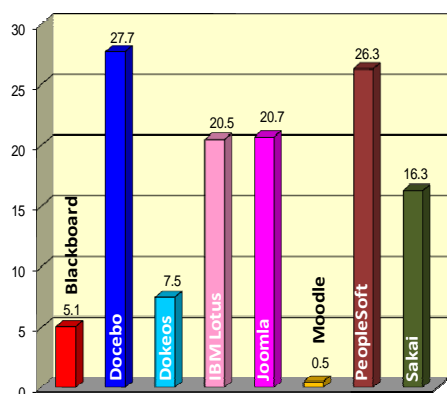


Figure 4: Total results obtained applying the third MCDM method.

## 4 CONCLUSIONS

In the application of MCDM methods to make a decision based on the results, Hobbs and Meier (1994) recommend to apply more than one approach because different methods offer different results to compare, in this case, goal programming and additive value functions are suggested and besides the results must be shown to decision makers who can mull over the differences or confirm the resemblances. In evaluating the results of different methods, the potential for biases should be kept in mind. The extra effort is not large; the potential benefits, in terms of enhanced confidence and a more reliable evaluation process, are worth. However the results shown in this paper deploy the same ranking of choices it does not matter the method used as opposed in (Hobbs and Meier, 1994).

The model can be used to analyze a broad variety of different e-learning technologies, the paper address synchronous and asynchronous web-based environments where learning content or courseware is served from a web server and delivered on demand to the learner's workstation. Learners can thus make progress by themselves. The courseware may be comprised of any combination of text, images, animation, sounds and movies. The courseware is interactive and is often combined with some type of assessment.

One of the main benefits obtained with the evaluation of several e-learning tools from a general perspective and from different points of view is that personnel related in evaluating and selecting an appropriate e-learning tool is now informed about this type of technology. The decision can be made taking into account: management, technological and

instructional characteristics. Furthermore, they can make up an action plan and choose the best path to follow in order to integrate this technology into their learning and training processes.

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