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Group Assessment of Learning Management Systems

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Abstract

In our earlier works (Srdjevic et al., 2012; Pipan et al., 2013) it was shown that if there are several available Learning Management Systems (LMS), a multi-criteria method AHP (Analytic Hierarchy Process) or DEXi multi-criteria model can be used to support decision maker in selecting the most suitable system. The decision making results of the application obtained by the individual expert using above mentioned methods have been already compared and published in Pipan et al. (2013). Here we extend an approach to group assessment. Three experts from the Technology Enhanced Learning (TEL) domain evaluated the same three LMSs against five typical criteria and their individual decisions were aggregated geometrically to obtain the final group decision. Unbiased weighting of decision makers is assumed and the consistency indicators were checked for each decision maker to justify associated equal weights and preserve that the final decision was correctly derived.

Keywords: learning management system, analytic hierarchy process, DEXi, group decision making, consistency measures

1 Introduction

There are many open source Learning Management Systems (LMSs) on the market that can be obtained for free (e.g., Moodle, Sakai, Claroline, ATutor, etc.) or through payment (e.g., Blackboard, WebCT, Clix, etc.). As stated in (Cavus, 2010), LMS supports different features which can be used as evaluation criteria and analyzed from different aspects such as pedagogical aspect, technical aspects, administrative aspect etc. Pedagogical aspect includes learner's and tutor's environment, course and curriculum design, authoring tools and technical specification. In multi-criteria assessments, each feature can be understood as criterion with usually many 'sub-features' (sub-criteria).

Technical features (criteria) as indicated in Kurilovas (2009) is overall architecture and its implementation which includes system interoperability, cost of ownership, strength of the development community (for open source products), licensing, internationalization and localization, accessibility and document transformation etc. Again, there are technical sub-features (sub-criteria). For details about the groups of features interested reader may consult references (Cavus, 2010; Kurilovas, 2009; Srdjevic et al., 2012).

Being aware of that selection of the most suitable LMS is a complex task that involves defining the evaluation criteria and possibly large sets of sub-criteria, we adopted selecting method which handles representative features of LMSs and enables sufficiently comprehensive and trustful systematic evaluation of optional LMS in group decision-making environment.

The most popular method that deals with decision hierarchies is Analytic Hierarchy Process (AHP) (Saaty, 1980) and we proposed this method for the evaluation of selected LMSs because: '(1) it supplies management in both education and industry with a less complex and more appropriate and flexible way to effectively analyze LMSs, (2) it supports their selections of an appropriate product, and (3) achievement of a higher level of learners' satisfaction'; see (Shee and Wang, 2008; Srdjevic et al., 2012). The other important feature of AHP is that it directly provides a measure of consistency of the evaluator, and, what is mostly important here, that it can be used to support participative (group) decision making.

In our research the problem is stated as to select most suitable LMS among three available. In the hierarchy tree LMSs are positioned as alternatives at fingertips, while at upper levels there are sub criteria grouped appropriately under three main criteria. AHP is used individually by three TEL experts and their preferences were finally geometrically aggregated to obtain the final group decision, that is, to identify the most appropriate learning management system.

2 The analytic hierarchy process

The AHP (Saaty, 1980) is a widely recognized methodology for solving decision-making problems with multiple criteria and alternatives. It is efficient in use and transparent to one or more decision makers in both instances: (1) while structuring the hierarchy of the problem in hand and judging its elements; and (2) while interpreting the final results represented by the overall weights of alternatives with respect to a stated goal. Thousands of applications world-wide and the reported results of researchers and practitioners show that the AHP is a widely accepted and reliable concept in both the individual and group contexts. The philosophy of the AHP is to manage the whole hierarchy and produce numerical values that explicitly transmit the internal information contained in the local matrices. The AHP is structured to enable local judgments, compute the local priorities of the judged local decision elements, and provide the final summary information, i.e., the weights of alternatives versus the specified goal at the top of a hierarchy. The synthesis process in the AHP is direct and is represented by the summation of the weighted local priority vectors, where the weights are taken from the adjacent upper hierarchy level.

There are several commonly used consistency measures associated with the AHP in the individual and group contexts. In both contexts local consistencies are computed at all the nodes of a hierarchy, and the global consistency can be computed for the hierarchy as a whole. Whichever method is used to derive the priority vector from the given local AHP matrix (Srdjevic, 2005), if it already has all the entries elicited from the DM, the measuring consistency is necessary in order to ensure the integrity of the outcomes. In our approach, we use two consistency measures as criteria for assessing the prioritization results at local levels in the AHP across the involved decision makers. The author of the AHP, T. Saaty (1980), defined a method to compute the global consistency ratio (GCR) by appropriately weighting the local consistency ratios (CRs). Therefore, GCR indicates the overall consistency demonstrated by the decision maker. The other commonly used consistency measure in standard AHP applications is the total Euclidean distance computed by summarizing all local EDs in the hierarchy. Analogously to GCR, overall (global) Euclidean distance can be labelled as GED. Both measures refer to deviations between ratios of derived priorities (weights) and initial decision maker's judgments.

If there is more than one DM, there are different approaches to the aggregation of individually obtained priorities (e.g., Forman and Peniwati, 1998; Srdjevic and Srdjevic, 2013). In this research we used the weighted geometric mean method to aggregate (final) individual priorities (Forman and Peniwati, 1998). Because differentiating decision makers is challenging issue (out of scope in this work) and hardly justified, our decision was to associate equal weights with all the decision makers.

3 Group evaluation of learning management systems

To evaluate the three LMSs, we asked three experts in the subject area to assess the usability characteristics of Blackboard 6, Clix 5.0 and Moodle 1.5.2. A four-level hierarchy was created following earlier assessments of the same problem (Srdjevic et al., 2012; Pipan et al., 2013). The AHP was used individually by the experts and the computed final weights of the LMSs which base on the demonstrated consistencies of the experts were compared. The eigenvector (EV) prioritization method is applied for all the local judgment matrices and a unique global consistency measuring framework GED-GCR is created for the comparison of the individually obtained final results. The individual final weights of all three experts were aggregated geometrically into the final group weights.

The problem is stated so as to assess and rank by applicability the three LMSs based on three typical qualitative criteria and a number of qualitative sub criteria (Pipan et al., 2010; Srdjevic et al., 2012; Pipan et al., 2013;). The four-level hierarchy, shown in Figure 1, is used as in Srdjevic et al. (2012).

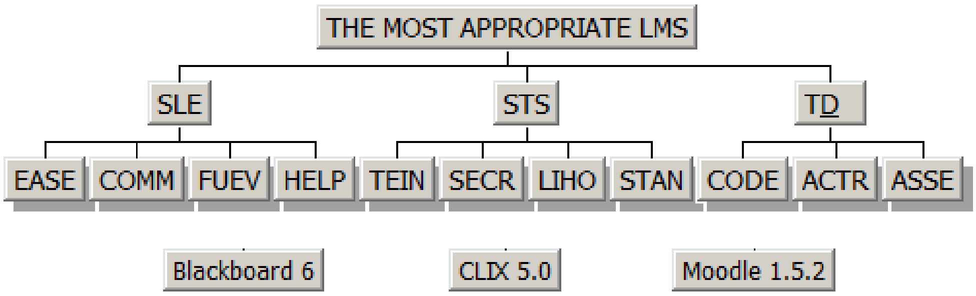

Figure 1: Hierarchy of the decision problem (Srdjevic et al., 2012)

The goal is defined as Identify LSM with the best applicability characteristics. Explanations of abbreviations for criteria and sub-criteria are given in Table 1.

Criteria	SLE *Student's learning environment*	STS *System, technology & standards category*	T&D *Tutoring & didactics*
Sub-Criteria	EASE *Ease of use*	TEIN *Technological independence*	CODE *Course development*
	COMM *Communication*	SECR *Security and privacy*	ACTR *Activity tracking*
	FUEV *Functional environment*	LIHO *Licensing & hosting*	ASSE *Assessment criteria*
	HELP *Help*	STAN *Standards support*	

Table 1: Criteria and Sub-criteria

The group of three experts in the e-learning field, and in particular with a significant knowledge of usability and in UX requirements (standards), took part in this experiment. The experts are treated as fully independent evaluators and are identified hereafter as decision makers DM1, DM2 and DM3. Notice that the AHP based assessments of the evaluator DM1 are reported in Srdjevic et al. (2012) and replicated here in a group context with two more experts involved in evaluating the same problem.

After a brief explanation of the AHP concept and the method of its use, the three experts compared in pairs, firstly, criteria versus goal, then sub criteria versus criteria, and finally alternatives versus sub criteria. In this way, each decision maker filled 15 matrices with numbers from fundamental judgment (9-point) scaley's scale, one at the criteria level, three at the sub criteria level and 11 at the alternatives level. In total 3×15=45 comparison matrices are created by the decision makers. The local weights of the decision elements for all the comparison matrices are computed by the EV method and the 'local consistency measures' ED and CR are also computed and associated with the corresponding matrices.

The AHP synthesis is performed for each decision maker to obtain the alternatives' (LMSs') weights as the individual decisions. In turn, the consistency measures GED and GCR, are computed and with equal weights being assigned to the decision makers, the AIP method is finally applied to derive the final group decision. All main results are summarized in Table 2.

Alternatives	DM1	DM2	DM3	AIP (GMM)
Blackboard 6	0.257 (2)	0.187 (3)	0.189 (3)	0.216 (3)
CLIX 5.0	0.590 (1)	0.448 (1)	0.399 (2)	0.489 (1)
Moodle 1.5.2	0.152 (3)	0.366 (2)	0.412 (1)	0.295 (2)

Table 2: Alternatives weights computed for the individual experts and the group weights obtained by the aggregation method AIP

Based on the demonstrated consistencies (see Table 3), it was easy to conclude that the DM1 was more consistent than other two decision makers, and that the group final decision (the most suitable LMS) coincided with his top preference (verify this from Table 2).

Global consistencies	DM1	DM2	DM3	Average (DM1,2,3)
GED	22.135	29.951	33.949	28.678
GCR	0.059	0.149	0.092	0.100

Table 3: Global individual and group consistencies

4 Discussion

The AIP aggregation of the final weights of three alternative learning-management systems obtained by the three experts indicated that CLIX was the best one, Moodle was second, and Blackboard was third. That order fully corresponds with the two decision makers, i.e., DM1 and DM2. The third decision maker (DM3) thinks that Moodle is the best, followed by CLIX and Blackboard.

Being a typical outcome of the AHP, the cardinal values (weights) shown in Table 2 clearly indicate that CLIX 5.0 for the first decision maker receives 59% of admiration, leaving Blackboard with nearly 26%, and the remaining 15% to Moodle. A similar interpretation follows for the other two decision makers. Notice, however, that DM3 ranked Moodle as the first (with 41%) and CLIX as the second (40%).

It is interesting at this point to recall that all the decision makers were asked to allocate percentages to the three LMSs after they completed the AHP evaluation. Several days later they performed a direct evaluation of the LMSs by weighting them to sum up to 100%. Intentionally, in this way some time is given to the decision makers just 'to forget about the AHP' and perform direct evaluations under the logical assumption that they will keep in mind, at a certain integrated level, the same criteria and sub criteria as they have previously used in the AHP.

Alternatives	DM1	DM2	DM3	Average
Blackboard 6	0.32 (2)	0.34 (2)	0.33 (2)	0.33 (2)
CLIX 5.0	0.44 (1)	0.48 (1)	0.40 (1)	0.44 (1)
Moodle 1.5.2	0.24 (3)	0.18 (3)	0.27 (3)	0.23 (3)

Table 4: Direct evaluation of LMSs by decision makers (without AHP)

Individual opinions obtained with the AHP and by direct evaluation differ, as can be seen from Tables 2 and 4. In the direct weighting all three decision makers agreed that CLIX is the most appropriate, followed by Blackboard and Moodle. A comparison of the corresponding cardinal values (and the resulting ranks) in Tables 2 and 4 shows that only DM1 provided the same ranking of LMSs for both instances, with and without the AHP.

5 Conclusions

In this paper we present a group evaluation of three well-known versions of learning management systems known as Blackboard 6, Clix 5.0 and Moodle 1.5.2. The evaluation was individually performed by three experts in e-learning with a multi-criteria decision-making method AHP. The group context is created with the help of aggregation scheme for ranking the three systems. The experts agreed to use common criteria and sub-criteria, which provide a valuable insight into the typical usability characteristics of e-learning platforms. The same hierarchy of the decision problem is used by each expert and the elicited judgments are mathematically interpreted within the AHP methodology. The individually obtained final prioritizations of the LMSs are aggregated geometrically.

An outcome of this research is that applied aggregation scheme generated group solution which corresponds with the solution obtained by the most consistent decision maker. While deriving group solution it was assumed that the involved decision makers are of the equal importance, regardless of their demonstrated (in)consistencies at the local nodes of the hierarchy. Associating different weights to decision makers is not an easy task and it is not implemented in our work. A possible approach could be to weight the decision makers according to their consistencies, e.g., by normalizing the reciprocals of the individual global ED and CR or their normalized and weighted sums. Because the final AHP synthesis is based on computing the hierarchy-wise weighted additive utilities of alternatives, further research should be focused at more precise measuring group consistency in order to preserve coherent and reliable results. An interesting research agenda could include an investigation of feedback effects when inconsistencies occur, and identifying the methods that may improve the decision makers' judgments.

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