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Evaluation of e-learning platforms suitable for Agriculture and Forestry Higher Schools: A case study using ELECTRE III

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Abstract: *In this paper the authors carry out a multiple criteria evaluation of 40 characteristics of e-learning platforms, in order to find the most suitable to meet the needs of an e-learning course for higher schools with Agricultural and Forestry content. The evaluation data came from a Delphi survey method, where experts' opinions are reflected. These data were introduced in ELECTRE III, a multi-criteria analysis (MCA) application. For each of the criteria, rating of the characteristics, such as Content, Structure, Communication, Evaluation, Functionality and General properties, of an e-learning platform is applied through a weighting factor. Each criterion has also been rated, depending on whether it was provided from the platform. As a result of this study, taking into consideration the characteristics mentioned above, and with the completion of the classification process of e-learning platforms via ELECTRE III, the most suitable e-learning platform was selected.*

Keywords: *Agriculture and Forestry Higher Schools, e-learning platforms, Delphi survey, ELECTRE III Multicriteria analysis.*

I. Introduction

The quick and massive development of technology in the last twenty years has caused many changes in the education field [1]. The electronic services provided by the new Information and Communication Technologies (ICT's), have been presented as an important tool in efforts to disseminate the e-learning in modern education. The new technologies have entered our lives dynamically and online services are the lever for sustainable regional development [2]. With the advent of globalization the character of higher education is set of change. Higher education to be meaningful and productive must have avenues for excellence to flourish and develop. [3] With advances in technology-driven delivery media, distance learning has done more than simply revolutionize the educational process. It has completely changed the strategic landscape [4]. E-learning has become one of the most important technologies of the modern era. E-learning is a learning process which aims to create an Interactive learning environment based on the use of computers and the internet [5]. A growing number of higher education institutions have adopted asynchronous and synchronous Web-based learning platforms to improve students' learning efficiency and increase learning satisfaction in the past decade [6]. Web-based learning has many advantages and its usage has extended over the years [7]. With advances in technology-driven delivery media, distance learning has done more than simply revolutionize the educational process. It has completely changed the strategic landscape [4]. Social software has already led to the widespread adoption of portfolios for learners, bringing together learning from different contexts and sources of learning and providing an ongoing record of lifelong learning, capable of expression in different forms [8].

According to literature, there have been several assessment approaches of eLearning platforms [6], [9]–[14]. But this effort has concretize the search for the most appropriate e-learning platform for Higher Schools with Agricultural and Forestry content. A Survey following the Delphi method took place, in order to reflect the opinion of experts on the requirements of an e-course, which will also cover the needs and requirements for transmission of skills and contact with the field, which are characteristics of these sciences.

The traditional Forecast methods with questionnaire although adequately reflect this aspect of a population group on one or more questions, have a disadvantage in the prediction of future developments due to multiple interdependencies between factors that influence the shaping of these developments. To remove this disadvantage, the Delphi method was developed, an attempt to solve this problem by activating the intuition and experience [15]. The Delphi method has proved a popular tool in research of information systems to identify and prioritize issues to assist in decision making. It's a team approach used to investigate and collect the view and the opinion of experts, on a particular topic, creating communication procedures between them to eventually

work as a whole in the face of complex problems. In the case of this study, the Delphi survey method was used for issues of new technologies in education and e-learning, in order to exploit the possibility of convergence of the views of experts to evaluate platforms of e-learning that will meet the needs for standard electronic design courses for Agricultural and Forestry lessons, identifying and describing the structure and content factors that should be taken into account [15]–[18].

Multi Criteria Analysis (MCA) is a systematic logic and mathematical approach that helps decision makers to resolve dilemmas arising from pursuing several conflicting objectives in decision making. The fulfillment of these objectives in no case can be complete. The MCA decomposes a complex problem, check whether available alternatives meet their targets, gives weighting at targets and then reconfigure parts of the problem [19]. In this way the one who takes the decisions is able to make less painful compromises and minimize the chances of regretting the choice he made [20]. The scientific area of MCA in principle, comprises a theoretical background, in which the basic logic grows to approach these problems. It even identifies the main components of the problem and analyze their basic properties. Based on this theoretical background has developed a number of techniques, suitable for the treatment of a wide range of problems that arise in practice [21], [22]. Based on the particularities of the decision-making problems with multiple criteria, the MCA area has three main objectives [23], the analysis of the competitive nature of the criteria, the modeling of decision feedback preferences, and identifying satisfactory solutions. Each problem is defined by certain structural characteristics, whether resulting from the nature of the problem or the views and preferences of the decision maker. The identification of the object of multi-criteria analysis on these characteristics is a first stage of the screening process, which facilitates the understanding of the problem and allows the selection of appropriate solving method [24]. The family of multi-criteria analysis methods ELECTRE is a set of outranking methods using the rule of the bilateral relationship supremacy between alternatives on the basis of which an assessment of the degree of validity of the preference of one option over another alternative. The aim of ELECTRE methods is the choice of an alternative set of "good" score based on the criteria of majority without having "bad" score according to the other criteria[25], [26]. The technics of the methods of theory of precedence relations is based on two stages. At first stage, a superiority relationship is developed (outranking relation) between alternative tests and in the second, the configured relationship is exploited, resulting in evaluating alternatives based on the selected problem (selection, classification, classification, description) [27].

II. Methodology

The novelty of the ELECTRE III method is the introduction of pseudo-criteria instead of true-criteria [28]. The outranking relation can be interpreted as a fuzzy relation. The construction of this relation requires the definition of credibility index, which characterizes the credibility of the assertion "a outranks b», with ρ(aSb) denote this index. It is defined using both the concordance index, c(aSb), and an discordance index for each criterion g_i in F that is, d_i(aSb).[29].

The starting point for most supremacy methods is a decision table that describes the performance of the alternatives to be evaluated against established criteria. The analysis results are a superiority compared to all alternatives. An alternative a is said to be better than another alternative b if, taking into account all available information on the problem and the preferences of the researcher, there is a fairly strong argument to support the conclusion that a is at least as good as b and with no strong argument against.

Algorithm

1. The start point is the decision matrix. The parameters p_i, q_i and v_i have to be defined by the user.
2. Calculate concordance index for each criterion:

$$d_ı(aSb) = \begin{cases} 0, \text{ if } gi(b) \geq gi(a) + pi(gi(a)) \\ 1, \text{ if } gi(b) \leq gi(a) + qi(gi(a)) \\ \frac{gi(b) - gi(a) - pi(gi(a))}{vi\,(gi(a)) - pi\,(gi(a))}, \text{ otherwise} \end{cases} \quad \textbf{(1)}$$

3. Calculate overall concordance index.

$$C(a, b) = \frac{\sum wiCi(a,b)}{\sum wi} \quad \textbf{(2)}$$

4. Calculate discordance index for each criterion:

$$Di(a,b) = \begin{cases} 0, \text{ if } gi(b) \leq gi(a) + pi(gi(a)) \\ 1, \text{ if } gi(b) \geq gi(a) + vi(gi(a)) \\ \frac{gi(b) - gi(a) - pi(gi(a))}{vi\,(gi(a)) - pi(gi(a))}, \text{ otherwise} \end{cases} \quad \textbf{(3)}$$

If no veto limits determined (v_i), then Di(a,b)=0 for all pairs of alternatives.

5. Calculate credibility index:

$$S(a,b) = \begin{cases} C(a,b), & \text{if } Di(a,b) \le C(a,b)\ \forall i \\ C(a,b)\ \prod_{Di(a,b)>C(a,b)} \frac{1-Di\,(a,b)}{1-C(a,b)}, & \text{otherwise} \end{cases} \quad \textbf{(4)}$$

If no veto thresholds (vi) are specified S(a,b) = C(a,b) for all pairs of alternatives.

6 Determine rank order.

An e-learning platform is a Course Management System, meeting the learning needs of registered members that focuses more on learning information and less on learning itself. It is a software for management, documentation, monitoring and reporting of training programs, online events, e-learning and educational content. [30]. More specifically, it enables management roles (eg teacher, student), learner registration, confirms entries, generates reports on the number of students enrolled in a course, makes courses available, collect scores, provides courses calendar, creates reminders about the program of the course, records the completion of courses to communicate it to the teacher and informing the student, creates assessment test and display count, enables discussions, sending and receiving messages, the ability to track participation in the lesson and provides learning paths (the student can choose to follow a path through the available online activities). The learning objects, ie small digital content units, may include assessment quiz, glossaries, didactic material (text, images, web pages, audio, video), simulations etc. [31]**.**

As part of this research our purpose is to evaluate characteristics of e-learning platforms, in order to select the most appropriate, which will be used to create am online e-learning course for Agricultural and Forestry Higher Schools. The most popular e-learning platforms, are shown in a market Distribution Chart (fig. 1) [32]. The platforms that will be compared through the ELECTRE III method in this study, depending on the results that were exported from the Delphi survey that took place in Greece and are the following: a_1: Blackboard, a_2: Moodle, a_3: Open e-class, a_4: A-Tutor.

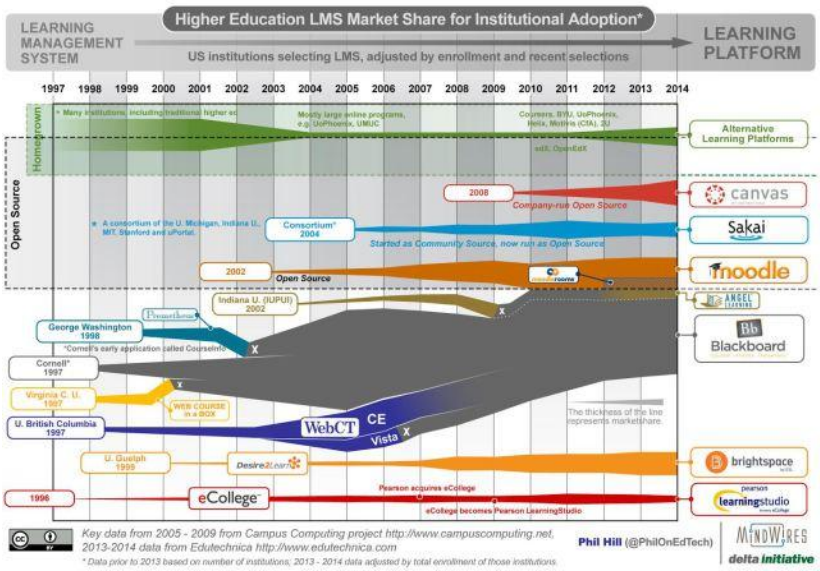

Figure 1. Market Distribution Chart of LMS platforms.

The characteristics of the platforms to be selected, will be compared through the ELECTRE III method.

For each platform, characteristics were selected as criteria to be calibrated (fj). These features are the most important as it appears from the literature [3], [11], [33], [34]. For each of the criteria, a weighting factor is applied, depending on their importance, which for this paper came from the Delphi survey, as experts gave weight to each criterion. The weighting factors for the particular multicriteria analysis application, which derived from the arithmetic average of experts' weight to each criterion, are presented in Table 1. The six criteria and characteristics of each, taken into account in the survey are:

- **Content:** Notes, Learning material, attending lectures, help – support, bibliography - sources, papers, comments - suggestions, file exchange, table of contents.
- **Structure:** Open source platform, Security, User collaboration in teams, support Blended learning, Hierarchical structuring courses, metadata, Course objects organization,
- **Communication:** Announcements, Forum, Chat, e-mail / messages, Conference, Polls, Blog, Calendar
- **Evaluation:** Exercises, Tests with immediate evaluation, Feedback
- **Functionality:** Easy to install, User management, course management, Virtual Classroom, Virtual field trip, Integrating multimedia, user-friendliness, Personalization

- **General properties:** statistics, online users ID and Profile, Scalability, Compliance with standards (scorm), Import-Export Data.

Each criterion has also been calibrated on a scale from 0-5, depending on whether they are provided from the platform (if not the zero value is given). The scores for each criterion per e-learning platform, are presented in table 2.

III. Results

The MCA conducted with ELECTRE III / IV software, which starts with a finite set of actions that have been evaluated based on a coherent pseudo-criteria group into a fuzzy precedence relation. Upon completion of the Delphi survey among experts from throughout the country, the results of both phases of this survey were used to construct and run the MCA, in order to classify e-learning platforms selected by experts.

Table 1. The main characteristics and their importance in an e-learning platform

Characteristic	weight	Characteristic	weight
Open source platform	4,17	Exercises	4,58
Notes	4,42	Tests with immediate evaluation	4,50
Learning material	4,75	Feedback	4,42
Attending lectures	4,37	Help – Support	4,65
Bibliography - sources	4,45	User collaboration in teams	4,21
Papers	4,47	File Exchange	4,47
Comments - Suggestions	4,10	Virtual classroom	3,75
Table of Contents	4,40	Virtual field trip	3,05
Announcements	4,60	Blended learning	4,21
Forum	4,25	Statistics	4,11
Chat	3,50	Online user ID - profile	4,56
e-mail / messages	4,47	Scalability	4,44
Conference	3,68	Compliance. with standards (scorm)	3,67
Polls	2,89	Metadata	4,06
Blog	2,84	Import Export Data	4,56
Calendar	3,89	User friendly	4,80
Easy to install	4,37	Security	4,65
Personnalization	3,94	Courses management	4,74
User management	4,72	Course objects organization	4,47
Multimedia	4,63	Hierarchical structuring courses	4,18

With the launch of ELECTRE III/IV software and the option to create a new data set, a periphrastic description of the program is introduced. The initial data needed for the MCA process, are the definition of alternative factors that we want to classify as well as the criteria and their severity. So for each alternative we define the name and its code. In the case of criteria, other than the definition of the name and the code for each one, the application requires and the declaration of their weight, as listed in Table 1, which is based on the preferences of the experts, as resulted from the Delphi survey. At the end of this process we have a materialized list of all criteria and their weighting.

After entering the necessary parameters in the first stage, the software creates a two-dimensional array B (m, n), where each alternative m is corresponding to n criteria. Each element b_{aj} represents the value that the alternative has, to a typical g_j. The table that is created, is filled by the researcher giving values for each criterion and each alternative. The values given in the cells of this table are taken from the Delphi survey, as shown in Table 2. Upon completion of the filling, thresholds values are imported.

By entering all the data in ELECTRE III/IV application, the calculation process of the results starts. The results are shown in tabular form in which are presented the superiority and ranking among the platforms tested, with numerical values or notations (Figure 2). Furthermore diagrams are created, depicting the primary flow between alternatives. Based on the above, and on the data entered in ELECTRE from the Delphi survey, it seems that the most appropriate e-learning platform for Agricultural and Forestry courses (Figure 3) is Moodle (A0002), followed by Open e-Class (A0003), BlackBoard (A0001) and A-Tutor (A0004).

Table 2. Rate per criteria parameter for each e-learning platform

Characteristic	Moodle	Black board	Open e-class	Tutor
Notes	4,63	4,17	4,60	3,00
Learning material	4,25	4,00	3,80	3,00
Attending lectures	3,50	3,67	4,00	3,00
Help – Support	3,50	3,83	3,60	3,00
Bibliography - sources	4,13	3,83	4,20	4,00
Papers	4,63	4,17	4,60	5,00
Comments - Suggestions	3,63	3,50	4,00	3,00
File Exchange	3,88	3,67	4,00	4,00
Table of Contents	4,50	4,00	4,40	5,00
Announcements	4,25	3,83	3,40	3,00
Forum	3,88	4,17	3,60	3,00
Chat	2,75	3,33	3,00	2,00
e-mail / messages	4,25	4,33	4,40	5,00
Conference	3,13	3,33	3,40	3,00
Polls	3,75	3,33	4,00	4,00
Blog	3,50	3,33	3,40	3,00
Calendar	3,63	3,67	4,00	4,00
Easy to install	3,75	3,50	3,40	3,00
User management	3,88	3,67	3,40	3,00
Courses management	3,75	3,50	3,40	5,00
Virtual classroom	3,88	3,50	4,00	4,00
Virtual field trip	3,43	3,00	2,80	2,00
Multimedia	3,75	3,33	3,40	3,00
User friendly	3,75	3,17	3,40	3,00
Personalization	3,88	3,33	4,00	4,00
Exercises	4,13	3,83	4,20	4,00
Tests (immediate evaluation)	3,88	3,50	3,40	4,00
Feedback	4,00	3,50	3,40	3,00
Open source platform	4,00	3,17	4,00	5,00
Security	4,25	4,17	4,20	4,00
User collaboration in teams	4,00	3,33	3,40	3,00
Blended learning	4,00	3,83	4,00	4,00
Hierarchical structuring	3,88	3,33	3,40	3,00
Metadata	4,00	3,80	2,75	N/A
Course objects organization	4,13	3,67	4,00	4,00
Statistics	3,88	3,83	4,20	5,00
Online user ID - profile	4,00	3,83	3,00	4,00
Scalability	4,25	3,17	3,50	5,00
Compliance. with standards	4,00	3,60	4,25	N/A
Import Export Data	4,13	3,50	4,00	4,00

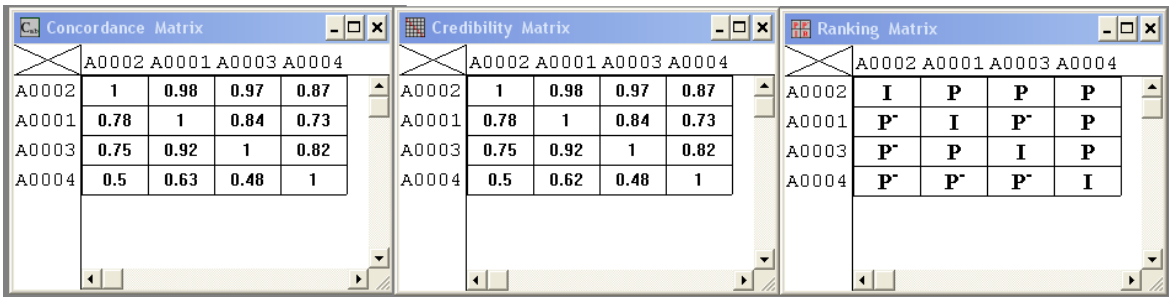

Figure 2. Concordance, Credibility and Ranking Matrix.

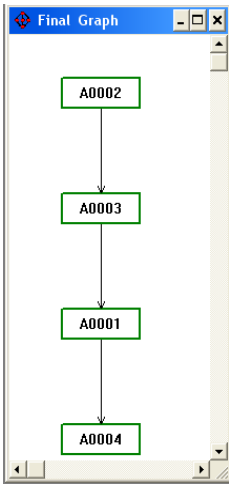

Figure 3. Final Graph

IV. Conclusion

E-learning is not simply text and publishing material on the Internet or posting scores and announcements. It is a series of interactions between instructor-learner-learning material, in order to transfer knowledge and skills via the Internet. To achieve that we can use between many Open Source E-learning Platforms in the world which have some similar function, some of them better than other when we compare them. With the use of a Delphi survey method that concerns the calibration and grading of the characteristics of an e-learning platform such as Content, Structure, Communication, Evaluation, Functionality and General properties, and by using a multicriteria analysis application, ELECTRE III, the best and most comprehensive e-learning platform was selected. As a result of this study, and on the basis of these characteristics, and the completion of the classification process of e-learning platforms via ELECTRE III, showed that the most suitable is Moodle, which will be used for the implementation and development of e-course in Agricultural and Forestry Higher Schools.

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