A Proposed Framework for Evaluating Student's Performance and Selecting the Top Students in E-Learning System, Using Fuzzy AHP Method

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Abstract

With passing time, e-learning is finding more favors with academic people, since it provides learning opportunity anytime and anywhere. Assessment as one of the most important tools to improve the quality of high educational systems has been revolutionized with the appearances of new methods in education and development of new technologies in field of e-learnings. A good system for evaluating the learning achievement of students is the key to appreciating the aim of education. Recently, fuzzy set theory applied to many methods for the educational grading systems. In this study, a special framework, which considers several points of view of many experts by weighting fuzzy opinions, is proposed for the evaluation of students' performance in e-learning systems. The findings suggest a framework contained 6 main criteria and 24 sub-criteria that each one has a score considering their weight which determined during this study using fuzzy AHP method. This framework can be used for selecting the best students, specifically in higher education online learning systems.

Keywords: Assessment, Student Evaluation, E-learning, Fuzzy AHP, evaluation framework.

1. Introduction

Taking notice of academic performance, effective and organized measurement of the development of knowledge and skill especially in fields of individual activity that involve complex and challenging problems is highly notable (Hsieh et al, 2012). The new technological world has changed from earlier ages. Obstacles of global learning are falling down because of Information Technology (IT) and the internet advancement that leads to the world has become a very big warehouse of information, and learning is no longer limited by distance, location, or physical existence and people who like to learn can now become "invisible" students (Tham et al, 2005). E-learning systems have a great growth in recent years, because of the notable advantages of that, like flexibility, convenience, portability, and worldwide learning community. Therefore, e-learning is becoming critical for many real-world tasks, as such economic pressure on educational institutions to learn more flexible and to save costs (Abdellatief, 2011).

Evaluation of students ' learning achievement is the process of determining the performance levels of individual students related to educational goals and will be ensure that all students receive fair grading so as not to limit present and future opportunities of students. Thus, the system should be reviewed and improved regularly, to ensure that it is accurate, fair, and worthwhile to all students (Saleh, 2009). Thus, student performance evaluation is one of the important requirements of most educational institutions and universities. According to this result and the growing extension use of e-learning method,the need to do research in the field and provide a framework for evaluating performance of students in e-learning system delineates the necessity of conducting this research.

Certainly, some factors are more effective than others for evaluating students' performance, and should be more considered in evaluations, the previous common methods gave equal weights to each indicator and that is a weakness of the old evaluation methods. Another weakness is that sometimes the data or the responses of respondents do not have certainty, and should be considered a range of responses for questions. The fuzzy set theory introduced by Zadeh (1965), has been widely used in solving problems in several fields, and also recently it used in educational grading systems (Hsieh et al, 2012; Abdellatief, 2011; Saleh and Kim, (2009); Tham et al, 2005). Fuzzy AHP covers the flaws and weaknesses of the old methods mentioned above. In this paper, we used fuzzy AHP method for evaluating students' performance in e-learning systems, and finally presented a new framework for evaluating students' performance that can be used for selecting the best students, specifically in higher education online learning systems.

2. Literature Review

2.1. Online Learning System

Nowadays, revolution of the Internet has become a bridge for delivery online education. Therefore, online learning (used interchangeably with "e-learning") has received significant attention as a tool of supplying substitutes for traditional "face to face", instructor-led education (Douglas, 2004). It provides various opportunities to widen the learning setting for varied student's communities (Keengwe, 2010). Govindasamy (2002) argues that e-learning contains instruction delivered via all electronic media like the Internet, extranets, intranets, and hypertext/hypermedia documents. Pituch and Lee (2006) state that students will get various educational aid and communication approach from e-learning because of an existing wide-ranging technology employ to e-learning containing virtual classroom, computer-based learning, web-based learning, and digital collaborations (Urdan et al., 2000) Moreover, e-learning provided participation of students' independent of time and place, and regardless of geographic location (Richardson et al, 2003). Furthermore, E-learning systems can be present the following benefits (Rosenberg, 2001; Harun, 2002; Ismail, 2002; Gordon, 2003, Liaw et al., 2007):

- It lowers costs such as low recurring costs, and customer support costs;
- It makes more regulatory compliance;
- Its content is more timely and dependable;

- It is a just in time learning approach;
- It builds universal communities;
- It fulfills business needs;
- It retrains staff members;
- It offers an increasingly precious learner service.

Govindasamy (2002) stated that e-learning is a tool to solve problems of authentic learning and performance (Sandars et al, 2005) reported that the most generally stated advantages of e-learning were the availability of up-to-date information, the speed and accessibility to a wide-ranging resource, and the opportunity for the learner to work at their own terms and conditions.

Cantoni (2004) argued that delivery of e-learning is cheaper, it is self-paced (e-learning courses can be taken just in necessary time), it is faster (learners can skip what they already know), it offers consistent content (in contrast with traditional learning that different teachers may present different material about the same topic), it works from anywhere and anytime, it can be updated easily and quickly because the updated materials are simply uploaded to a server, it can make an increased retention and a better control on the subject (because of many elements such as audio, video, interaction, quizzes) and can be handled easy for large community of students.

Yang and Lin (2010) asserted that perception of learners about the internet might be different when they experience e-learning. Therefore, this raises an issue of learner perspective to use e-learning. The advancement of distribution technologies has encouraged many institutions to set about presenting online education (Kay, 2009). Development of new technologies such as simulations and interactive media lead to evolving distance education programs (Myers, 2007). Achievement in the institution's attempts to prepare good quality, suitable, and effective distance education is not a given, even if the courseware that is now being presented online was all right received in its classroom-based format (Smith, 2009). The last concern relates to the learning in the traditional brick and mortar classes being on balance with the online learning (Perantoni, 2010). Khan (2001) offers an e-learning framework with eight elements, such as technological, institutional, ethical, management, resource support, interface design, pedagogical, and evaluation components.

2.2. Assessment

Assessments are linked to learning and grading as a major component in a classroom, which are used to demonstrate a student's educational attainment.

"Assessments have become far more than merely one-time events attached to the end of the teaching; they have become part of the learning process by keeping students posted on their progress and confident enough to continue striving" (Stiggins, 2006).

Traditionally, assessments have been used in a summative method as assessments of learning, but recently, learning assessments are being used in a formative method (Collins, 2012). Summative assessments perform at the end of the learning process. Therefore, they are evaluative in nature, make judgments about achievement of a student, and are incorporated into grade of a student because of communicate their level of the standard educational attainment (Chappuis, 2009). According to (Chappuis, 2009), a definition of summative assessment is as "assessments that provide evidence of student achievement for the purpose of making a judgment about student competence or program effectiveness". Some common examples of summative assessments are major quizzes, end of unit tests; end of course tests (such as final exams), papers or projects (Collins, 2012).

Assessments should measure student performance and outcome in feedback to students about their performance. McConnell (1999) states that assessment may be one of the last remaining bastions of academic life, in a formal course it is usually the one element where the learner has no, or very little, opinion or control. Usually the instructor performs the assessment unilaterally with the final decision about learner performance being their personal view. The evaluation process scours to confirm whether the learning aims and outcomes have been performed and achieved efficiently (Rae, 1999).

Using test scores alone does not adequately measure the intricacies of learning, and should not be equated with the quality of student performance or learning (Tham et al, 2005).

3. Methodology

3.1. Conceptual Bases

3.1.1. Analytic Hierarchy Process (AHP)

The AHP method established to solve multiple criteria decision problems by setting their priorities (Karahalios, 2011) and to settle the conflict between practical demand and scientific decision-making, and to find a way to combine process qualitative analysis and quantitative analysis. AHP applied to making decisions in two sequential steps: design a hierarchy, which includes breaking down the decision problem into a hierarchy of interrelated decision elements (i.e., goal, and evaluation criteria); and hierarchy evaluation, which includes extracting weights of the criteria and incorporating these weights and preferences to specify alternative priorities (Sanjay and Ramachandran, 2006). AHP method is one of the widely used MCDM methods (Vaidya et al, 2006). One of the main advantages of the AHP method is the simple structure. The AHP is designed to represents human mind and nature. Thus, AHP can make a chance to search and evaluate the cause and effect relationship between goal, criteria, sub-criteria and alternatives using decomposing the structure of the problem (Milosevic, 2003). Furthermore, the application of AHP does not include burdensome mathematics; it understood easily and handled both qualitative and quantitative data in effect (Cengiz et al, 2003).

3.1.2. Fuzzy theory

Fuzzy set theory was specifically created to represent uncertainty and vagueness mathematically and provide formalized tools for dealing with the imprecision inherent to many problems. It resembles human reasoning in its use of approximate information and uncertainty to make decisions (Cengiz, et al, 2003). It also makes classes and grouping of data with boundaries that are not sharply defined (i.e., fuzzy) and it is easier to understand (Felix and Niraj, 2007).

The values of a linguistic variable are not numbers but words or sentences in a natural or artificial language (Zadeh, 1975). Fuzzy numbers express linguistic variables. A fuzzy number is a fuzzy set on the real line that satisfies the conditions of normality and convexity (Hadi, 2008). It is a quantity whose value is imprecise, rather than exact as is the case with “ordinary” (single-valued) numbers.

Usually A triangular or trapezoidal fuzzy number is applied to express the decision group’s perception of alternative’s performances with respect to each criterion (Debashree and Debjani, 2011). Indeed, a triangular fuzzy number (*TFN*) is a special case of a trapezoidal fuzzy number. When the two most promising values are the same number, the trapezoidal fuzzy number becomes a triangular fuzzy number (Debashree and Debjani, 2011). We use triangular fuzzy number for our research method, fuzzy AHP.

3.1.2.1. Establishing fuzzy number

Fuzzy set elements have degrees of membership. In classical set theory, the membership of elements in a set is assessed in binary terms according to a bivalent condition, an element either belongs or does not belong to the set (Liou et al, 2007) (Wu et al, 2007). The mathematics concept borrowed from (Liou et al, 2007) and (Hsieh et al, 2004).

A fuzzy number $\tilde{A}$ on R, to be a *TFN* if its membership function $\mu_{\tilde{A}}(x): R \rightarrow [0,1]$ is equal to following Eq. (1):

$$\mu_{\tilde{A}}(x) = \begin{cases} \frac{x-l}{m-l} (l \leq x \leq m) \\ \frac{u-x}{u-m} (m \leq x \leq u) \\ 0, otherwise \end{cases} \quad (1)$$

From Eq. (1), l and u mean the lower and upper bounds of the fuzzy number $\tilde{A}$, and m is the modal value for $\tilde{A}$. The TFN can be denoted by $\tilde{A} = (l, m, u)$. The operational laws of TFN $\tilde{A}_1 = (l_1, m_1, u_1)$ and $\tilde{A}_2 = (l_2, m_2, u_2)$ are displayed as following Eqs. (2)– (6).

Addition of the fuzzy number ⊕

$$\tilde{A} \oplus \tilde{B} = (l_1, m_1, u_1) \oplus (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2) \quad (2)$$

Multiplication of the fuzzy number ⊗

$$\tilde{A} \otimes \tilde{B} = (l_1, m_1, u_1) \otimes (l_2, m_2, u_2) = (l_1 l_2, m_1 m_2, u_1 u_2) \quad (3)$$

Subtraction of the fuzzy number ⊖

$$\tilde{A} \ominus \tilde{B} = (l_1, m_1, u_1) \ominus (l_2, m_2, u_2) = (l_1 - u_2, m_1 - m_2, u_1 - l_2) \quad (4)$$

Division of a fuzzy number ⊘

$$\tilde{A} (\oslash) \tilde{B} = (l_1, m_1, u_1) \oslash (l_2, m_2, u_2) = \left(\frac{l_1}{u_2}, \frac{m_1}{m_2}, \frac{u_1}{l_2}\right) \quad (5)$$

Reciprocal of the fuzzy number

$$(\tilde{A})^{-1} = (l_1, m_1, u_1)^{-1} = \left(\frac{1}{u_1}, \frac{1}{m_1}, \frac{1}{l_1}\right) \quad (6)$$

3.1.3. Fuzzy AHP

Since fuzziness and vagueness are common specifications in many decision-making problems, a good decision-making model needs to tolerate vagueness or ambiguity (Yu, 2002). Based on the concept of fuzzy set theory, fuzzy AHP was originally introduced by Van Laarhoven and Pedrycz (1983). Linguistic values, whose membership functions are usually characterized by *TFNs*, are recommended to assess preference ratings rather than conventional numerical equivalence method, because the fuzzy linguistic method can take the optimism/pessimism rating attitude of decision makers into account (Liang et al ,1994). Through AHP, the importance of several attributes is obtained from a process of paired comparison, in which the relevance of the attributes or categories of drivers of intangible assets are matched two-on-two in a hierarchic structure (Sun, 2010).

Therefore, the fuzzy-AHP method should be more suitable and effective than conventional AHP in real practice where an uncertain pairwise comparison environment exists (Lee et al, 2008).

There are many fuzzy-AHP methods proposed by various authors (Van Laarhoven et al, 1983; Chang, 1996; Cheng, 1997; Deng, 1999; Leung and Cao, 2000; Mikhailov, 2004).

These methods are systematic approaches to the alternative selection and justification problem by using hierarchical structure analysis and the concepts of fuzzy set theory. Decision-makers usually find that it is more confident to give interval judgments than fixed value judgments. This is because usually he/she is unable to explicit about his/her preferences due to the fuzzy nature of the comparison process.

Then, we will briefly introduce that how to accomplish the fuzzy AHP in the following steps (Sun, 2010).

Step 1: Construct pairwise comparison matrices among all the elements/criteria in the dimensions of the hierarchy system. Assign linguistic terms to the pairwise comparisons by asking which is the more important of each two dimensions, as following matrix $\tilde{A}$

$$\tilde{A} = \begin{bmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \cdots & 1 \end{bmatrix} = \begin{bmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ 1/\tilde{a}_{12} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/\tilde{a}_{1n} & 1/\tilde{a}_{2n} & \cdots & 1 \end{bmatrix} \quad)$$

Where

$$\alpha_{ij} = \begin{cases} 9^{-1}, 8^{-1}, 7^{-1}, 6^{-1}, 5^{-1}, 4^{-1}, 3^{-1}, 2^{-1}, 1^{-1}, 1, 2, 3, 4, 5, 6, 7, 8, 9, 1, i \neq j \\ 1 i = j \end{cases}$$

Step 2: To use geometric mean technique to define the fuzzy geometric mean and fuzzy weights of each criterion by (Hsieh et al, 2004)

$$r_i = (\alpha_{i1} \otimes \ldots \otimes \alpha_{ij} \otimes \ldots \otimes \alpha\ )^{1/n} \quad (8)$$

$$w_i = r_i \otimes^{-1}$$

where α_{ij} is fuzzy comparison value of dimension *i* to criterion *j*, thus, r_i is a geometric mean of fuzzy comparison value of criterion *i* to each criterion, w_i is the fuzzy weight of the *i*th criterion, can be indicated by a *TFN*, $w_i = (lw_i, mw_i, uw_i)$. The lw_i, mw_i and uw_i stand for the lower, middle, and upper values of the fuzzy weight of the i^{th} dimension.

3.1.4. Establish the decision group

A decision group composed of academic experts such as professors who had experiences in e-learning systems is firstly formed. In order to obtain representative views, knowledge coverage and different academic viewpoint of the decision makers should be considered, the ratio of them should be reasonably considered. If the decision group is established as above, fair and reliable evaluation results can be obtained.

3.2. Research Methodology

3.2.1. Establish the evaluation framework and indexes

The first step in this paper was included investigating literature review and interviews with executives and evaluation units of academic e-learning systems, that evaluation criteria and indicators have been identified. During the second step, a questionnaire was distributed among instructors and teaching assistants in e-learning systems, which criteria extracted from the literature and interviews, have been sieved to eliminate inappropriate and inconsequential criteria. According to collected answers, from criteria derived from the literature and interviews, 13 criteria were excluded. After removing the least important criteria, the remaining criteria were grouped into six main criteria that included totally 24 sub criteria. The final elected criteria are shown in Table 1.

Table 1. The final criteria and sub criteria for evaluating the performance of students in e-learning system

Sub-criteria	Main criteria	Row
Total grade point average (GPA) Each semester's GPA	Scientific-Educational	1
Having scientific research , academic promotion, national and international conferences and scientific meetings Activities and collaboration in research projects Book or book chapter compilation Participation in the preparation of university publications Translating and compiling books	Scientific-Research	2
Being creative and stylish content formats including student exercises, quizzes , projects and academic papers Patented inventions Plans and ideas in science and technology exhibitions inside and outside the country	Creativity, invention and innovation	3
Active interaction with professors, teaching assistants and the dept. chief Send assignments timely in Portal Participate in teamwork trainings Portal continuous activities in courses Active participation in online classes Participating in university and faculty surveys ICDL and Internet skills	E-activities	4
Experiences to being Teachers Assistant Teaching theoretical-practical Courses Teaching workshops and training courses	Sharing and spreading knowledge	5
Attending educational and research workshops Participate in Scientific Forum Activities Presence in professional meetings, forums, media, academic circles or webinar as an expert	Personal development activities	6

Top ranked in student's academic-research authentic competitions		

3.2.2. Determining the linguistic variables

Linguistic variables take on values defined in its term set. Linguistic terms are subjective categories for the linguistic variable. A linguistic variable is a variable whose values are words or sentences in a natural or artificial language. Here, we use this kind of expression to compare main-criteria for students performance evaluation together and also compare their sub-criteria together by nine basic linguistic terms, as "Perfect", "Absolute", "Very good", "Fairly good", "Good", "Preferable", "Not Bad," "Weak advantage" and "Equal" with respect to a fuzzy nine level scale. In this paper, the computational technique is based on the following fuzzy numbers defined by Gumus (2009) in Table 2. Here, each membership function (scale of fuzzy number) is defined by three parameters of the symmetric triangular fuzzy number, the left point, middle point, and right point of the range over which the function is defined.

Table 2: Linguistic scale of relative importance used in the pair-wise fuzzy comparison measures.

Fuzzy number	Linguistic terms	Triangular fuzzy numbers
1	Equal	(1, 1, 1)
2	Weak advantage	(1, 2, 3)
3	Not bad	(2, 3, 4)
4	Preferable	(3, 4, 5)
5	Good	(4, 5, 6)
6	Fairly good	(5, 6, 7)
7	Very good	(6, 7, 8)
8	Absolute	(7, 8, 9)
9	Perfect	(8, 9,10)

These linguistic variables used for pair-wise comparisons questionnaire that distributed to experts.

Before calculating the weights of the index, the consistency of the comparison matrix should be checked. As a rule, only if consistency were less than 0.10, it considered as acceptable, otherwise the pair-wise comparisons should be revised. In this research after inserting the details of all questionnaires into Expert Choice software, all consistencies were less than 0.02 that shows answers are consistence.

3.2.3. Weighting the criteria

For calculate overall weight of criteria, we use Expert Choice software for analyzing pair-wise comparisons according to fuzzy AHP method, that shows weights for each respond. First, we have multiplied each sub-criterion to its main criteria, for all responds. Then in order to averaging all responds (weights), we used geometric mean for criteria and sub-criteria (column "Overall weight" in table 3). Then, the percentage of the total weight was calculated. For this purpose, the geometric mean of each criterion divided to sum of them (column "Percentage" in table 3). This percentage shows weight of each criteria/sub-criteria relative to all criteria/sub-criteria. These weighted criteria and their sub-criteria and the rank of each of them displayed in table 3.

Table 3: Final weighted criteria and sub-criteria using fuzzy AHP

Main Criteria	Overall weight	Percentage	Sub-Criteria	Overall weight	Percentage
Personal development activities	0.237893558	26.11%	Top ranked in student's academic-research authentic competitions	0.080718637	10.41%
			Presence in professional meetings, forums, media, academic circles or webinar as an expert	0.072736485	9.38%
			Participate in Scientific Forum Activities	0.038048095	4.90%
			Attending educational and research workshops	0.019677011	2.54%
Scientific-Research	0.183812048	20.18%	Activities and collaboration in research projects	0.040035719	5.16%
			Having scientific research , academic promotion, national and international conferences and scientific meetings	0.038360416	4.95%
			Book or book chapter compilation	0.031345668	4.04%
			Participation in the preparation of university publications	0.025296112	3.26%
			Translating and compiling books	0.022661144	2.92%
Sharing and spreading knowledge	0.15924516	17.48%	Teaching workshops and training courses	0.053620923	6.91%
			Teaching theoretical-practical Courses	0.039882327	5.14%
			Experiences to being Teachers Assistant	0.035161155	4.53%
Creativity, invention and innovation	0.132905226	14.59%	Being creative and stylish content formats including student exercises, quizzes , projects and academic papers	0.045883003	5.92%
			Plans and ideas in science and technology exhibitions inside and outside the country	0.04585439	5.91%
			Patented inventions	0.019049835	2.46%
E-activities	0.113478507	12.46%	Participate in teamwork trainings	0.027301808	3.52%
			Portal continuous activities in courses	0.023457231	3.02%
			Active participation in online classes	0.015645358	2.02%
			Active interaction with professors, teaching assistants and the dept. chief	0.014582819	1.88%
			Participating in university and faculty surveys	0.006280225	0.81%
			Send assignments timely in Portal	0.006209796	0.80%
			ICDL and Internet skills	0.005937092	0.77%
Scientific-Educational	0.083662099	9.18%	Each semester's GPA	0.048601153	6.27%
			Total GPA	0.019358161	2.50%
Total		100%			100%

3.3. Final Framework

At the end, we should get final scores to each main criterion and their sub-criteria. For this purpose, the percentages acquired at last step (table 3) for each sub-criterion rounded (up or down) to be non-decimal scores. Total sum of these scores in each group will be the score of their main criteria. In this way, we scored all sub-criteria with respect to their weights and importance of their main criteria in scale “100” that are shown in table 4.

Table 4: Final framework for evaluating students’ performance in e-learning systems

Main Criteria	Score	Sub-Criteria	Score
Personal development activities	27	Top ranked in student's academic-research authentic competitions	10
		Presence in professional meetings, forums, media, academic circles or webinar as an expert	9
		Participate in Scientific Forum Activities	5
		Attending educational and research workshops	3
Scientific-Research	20	Activities and collaboration in research projects	5
		Having scientific research , academic promotion, national and international conferences and scientific meetings	5
		Book or book chapter compilation	4
		Participation in the preparation of university publications	3
		Translating and compiling books	3
Sharing and spreading knowledge	17	Teaching workshops and training courses	7
		Experiences to being Teachers Assistant	5
		Teaching theoretical-practical Courses	5
Creativity, invention and innovation	14	Being creative and stylish content formats including student exercises, quizzes , projects and academic papers	6
		Plans and ideas in science and technology exhibitions inside and outside the country	6
		Patented inventions	2
E-activities	14	Participate in teamwork trainings	4
		Portal continuous activities in courses	3
		Active interaction with professors, teaching assistants and the dept. chief	2
		Active participation in online classes	2
		Send assignments timely in Portal	1
		ICDL and Internet skills	1
		Participating in university and faculty surveys	1
Scientific-Educational	8	Each semester’s GPA	6
		Total GPA	2
Total	100		100

4. Results and discussion

According to table 4, the results of weighting demonstrate that among all main criteria, “Personal development activities” and “Scientific-Research” with score “27” and “20” out of “100”, respectively, are more important than the other criteria. Ranking of the main-criteria affecting on students’ performance evaluation in e-leaning system, in this research is as following:

1. Personal development activities;
2. Scientific-Research;
3. Sharing and spreading knowledge;
4. Creativity, invention and innovation;
5. E-activities;
6. Scientific-Educational.

As well as, the ranking of all sub-criteria shows in table 4. Briefly, we can say the most important sub-criteria are as follows:

1. Top ranked in student's academic-research authentic competitions (10);
2. Presence in professional meetings, forums, media, academic circles or webinar as an expert (9);
3. Teaching workshops and training courses (7);

4. Being creative and stylish content formats including student exercises, quizzes, projects and academic papers (6);
5. Plans and ideas in science and technology exhibitions inside and outside the country (6);
6. Each semester's GPA (6);
7. Experiences to being teachers assistant (5);
8. Teaching theoretical-practical Courses (5);
9. Participate in Scientific Forum Activities (5);
10. Activities and collaboration in research projects (5);
11. Having scientific research, academic promotion, national and international conferences and scientific meetings (5).

12. Conclusions

Students today are exposed to different learning environments to gain the maximum value in learning. Every institution is unique and has its own strengths in conducting online courses. Therefore, evaluating progress of students especially in online learning systems, and understand their performance is very important.

In this paper, the problem is the students' performance evaluation in e-learning systems that need some critical factors which will be weighted and scored to present a framework for this evaluation.

Compared with the existing students' performance evaluation methods, fuzzy AHP is a more systematic and efficient method than the other methods. Compared with the other MCDM methods and student's performance evaluation methods, the use of fuzzy AHP methodology offers a number of benefits. For example, the other MCDM method experiences difficulty in capturing uncertain and imprecise judgment of experts (Prasun, 2011). Fuzzy AHP can overcome such inability by handling linguistic variables. Thus, fuzzy AHP is an efficient tool for handling the fuzziness of the data involved in deciding the preferences or judgments of different decision variables (Sezhian, 2011). So we used of a fuzzy AHP method in the students' performance evaluation in higher education e-learning systems. For this purpose, first, 40 initial factors extracted from literature and interview with experts, that through a distributed questionnaire to expert, 13 factors excluded which included totally 24 sub-criteria. Secondly, via considering these criteria, the weights of six main criteria and their sub-criteria are calculated by using fuzzy-AHP. Then all sub-criteria scored with respect to their weights and importance of their main criteria, shown in table 3. Finally, the final framework based on non-decimal scores in scale "100" proposed in table 04. This framework shows the importance of each criterion for evaluating performance of students in e-learning system at higher education.

Most of universities assess their students annually, and select the best students regard to their achievement and performance in one last year or each semester passed. The results of this study can be used by these universities with online learning methods in higher education systems for evaluating their students annually.

We propose that this framework of assessment is effective for two purposes. First, we can evaluate student progress relative to multi dimensions, not only rely on their final exams. Second, although grades, as a measure of student learning, reflect student and instructor factors (Tomcho, 2008), we can use student performance data to demonstrate teaching efficacy and overall academic performance of university or institution. These two purposes are linked if, through this method of analysis, faculty and department of chief discover a low level of student's performance on a measure of student learning and, therefore, adjust their methods of teaching and policies to produce a better result. This intentional and iterative process of identifying student learning outcomes, linking the outcomes to course assessments, and examining the overall levels of student learning can inform teaching.

This assessment framework also offers one tool to inform students, and faculty can use assessments to provide evidence of student learning. A by-product of this framework of assessment is that it provides clear direction to students about the objectives that are important for the progress and it offers faculty a mechanism for evaluating progress toward those objectives. For example, students inform that such actions as presence in professional meetings, forums, media, academic circles or webinars as an expert; participate in scientific forum activities; or attending educational and research workshops that recognized at this framework as most important factors, helps clarify student proficiencies that should be evident at the end of the course. So students in an e-learning system can realize that for being most successful and advancing their capability, what measurement needs to do. So performance of the students will be more targeted.

The integrated evaluation system is designed to provide practitioners with a fuzzy point of view to traditional performance evaluation model for dealing with imprecision. The proposed method enables decision analysts to better understand the complete evaluation process. Furthermore, this approach provides a more accurate, effective, and systematic decision support tool. Furthermore, the further research can explore that how to improve the gaps in each criteria based on Network Relationship Map (NRM) and capture the complex relationships among these evaluation criteria. The NRM is not only to find out the most important criterion for the performance but also to measure the relationships among these evaluation criteria.

References

Abdellatief, M., Sultan, A. B., Jabar, M. A., & Abdullah, R. (2011). A technique for quality evaluation of e-learning from developers perspective. American Journal of Economics and Business Administration, 3(1), 157.

Cantoni, V., Cellario, M., and Porta, M. (2004). Perspectives and Challenges in E-learning: Towards Natural Interaction Paradigms. Journal of Visual Languages and Computing, 15, 333-345.

Cengiz, K., Ufuk C. & Ziya U. (2003). "Multi-criteria supplier selection using fuzzy AHP", Logistics Information Management, Vol. 16, No. 6, PP: 382 – 394.

Chang, D. Y. (1996). "Applications of the extent analysis method on fuzzy AHP". European cccJournal of Operational Research, Vol. 95, No. 3, PP: 649-655.

Chappuis, J. (2009). Seven strategies of assessment for learning. Portland, OR: Educational Testing Service.

Cheng, C. H. (1997). Evaluating naval tactical missile systems by fuzzy AHP based on the grade value of membership function. European Journal of Operational Research, 96(2), 343–350.

Collins, N. M. (2012). The Impact of Assessment for Learning: Benefits and Barriers to Student Achievemen. (Ph.D. Dissertations & Theses), Cardinal Stritch University, Ann Arbor. (3517764).

Debashree, G., Debjani, C. (2011). Fuzzy multi attribute group decision making method to achieve consensus under the consideration of degrees of confidence of experts' opinions. Computers and Industrial Engineering 60 (4), 493–504.

Deng, H. (1999). Multicriteria analysis with fuzzy pairwise comparison. International Journal of Approximate Reasoning, 21(3), 215 231.

Douglas, D.E and Van Der Vyver, G. (2004). Effectiveness of E-Learning Course Materials for Learning Database Management Systems: An Experimental Investigation. Journal of Computer Information Systems, 44(4), 41-48.

Felix, C.T.S., Niraj, K. (2007). Global supplier development considering risk factors using fuzzy extended AHP-based approach. Omega 35 (4), 417–431.

Gordon, J. (2003). E-learning Tagged as Best Corporate IT Investment. E-learning, 4(1), 8.

Govindasamy, T. (2002). Successful Implementation of e-learning pedagogical considerations. The Internet and Higher Education, 4, 287-299.

Gumus, A. T. (2009). Evaluation of hazardous waste transportation firms by using a two step fuzzy-AHP and TOPSIS methodology. Expert Syst. Appl., 36(2), 4067-4074. doi: 10.1016/j.eswa.2008.03.013.

Hadi, N. (2008). Fuzzy numbers: positive and nonnegative. International Mathematical Forum 36 (3), 1777–1780.

Harun, M.H. (2002). Integrating E-learning into Work-place. Internet and Higher Education, 4(3-4), 301- 310.

Hsieh, C.-S., Chen, Y.-W., Wu, C.-H., & Huang, T. (2012). Characteristics of fuzzy synthetic decision methods for measuring student achievement. Quality & Quantity, 46(2), 523-543.

Hsieh, T.-Y., Lu, S.-T., & Tzeng, G.-H. (2004). Fuzzy MCDM approach for planning and design tenders selection in public office buildings. International Journal of Project Management, 22(7), 573–584.

Ismail, J. (2002). The Design of an E-learning system beyond the Hype. Internet and Higher Education, 4(3-4), 329-336.

Karahalios, H., Yang, Z.L., Williams, V., Wang, J. (2011). A proposed System of Hierarchical Scorecards to assess the implementation of maritime regulations. Safety Science 49 (3), 450–462.

Kay, S. (2009). Student graduation studies in online education. Ed.D. dissertation, University of Pennsylvania, United States -- Pennsylvania. Retrieved February 15, 2010, from Dissertations & Theses: Full Text. (Publication No. AAT 3374180).

Keengwe, J., and Kidd, T.T. (2010). Towards Best Practices in Online Learning and Teaching in Higher Education. MERLOT Journal of Online Learning and Teaching, 6 (2).

Khan, B. H. (2001). A framework for Web based learning. In B. H. Khan (Ed.), Web based training (pp. 75-98). Englewood Cliffs: NJ: Educational Technology.

Lee, A. H. I., Chen, W.-C., & Chang, C.-J. (2008). A fuzzy AHP and BSC approach for evaluating performance of IT department in the manufacturing industry in Taiwan. Expert Systems with Applications, 34(1), 96–107.

Leung, L. C., & Cao, D. (2000). On consistency and ranking of alternatives in fuzzy AHP. European Journal of Operational Research, 124(1), 102–113.

Liang, G. S., & Wang, M. J. (1994). Personnel selection using fuzzy MCDM algorithm. European Journal of Operational Research, 78, 22–33.

Liaw, S.S. Huang, H.M. and Chen, G.D. (2007). "An activity-theoretical approach to investigate learners" factors toward e-learning systems, Computers in Human Behavior, 23.

Liou, J.-J.-H., Yen, L., & Tzeng, G.-H. (2007). Building an effective safety management system for airlines. Journal of Air Transport Management, 14(1), 20–26.
McConnell, D. (1999). Examining a collaborative assessment process in networked lifelong learning. Journal of Computer Learning, 15, 232-243.
Mikhailov, L. (2004). A fuzzy approach to deriving priorities from interval pairwise comparison judgments. European Journal of Operational Research, 159(3), 687–704.
Milosevic, D.Z. (2003). Project Management Toolbox. Tools and Techniques for the Practicing Project Manager. John Wiley & Sons Inc. Publishing, New York.
Mu, X.D. (1997). Grassland Systems Engineering. Chinese Agricultural Press, Beijing (in Chinese).
Myers, S. (2007). Evaluation of strategic leader cognitive development through distance education. Ph.D. dissertation, The Pennsylvania State University, United States -Pennsylvania. Retrieved October 21, 2010, from Dissertations & Theses: Full Text. (Publication No. AAT 3266168).
Perantoni, E. (2010). Course design based on the Kolb learning style as it relates to student success in online classes. Ed.D. dissertation, Lindenwood University, United States -- Missouri. Retrieved April 27, 2010, from Dissertations & Theses: Full Text. (Publication No. AAT 3389397).
Pituch, K.A. and Lee, Y-K. (2006). The influence of system characteristics on e-learning use. Computers & Education, 47.
Prasun, D. (2011). Selection of business strategies for quality improvement using fuzzy analytical hierarchy process. In: 5th International Quality Conference, May 20th, 2011. Center for Quality, Faculty of Mechanical Engineering, University of Kragujevac.
Rae, L. (1999). Using evaluation in training and development. International Journal of Manpower, 21(6): 511-515.

Richardson. J.C., and Swan, K. (2003). Examining social presence in online courses in relation to students' perceived learning and satisfaction. Journal of Asynchronous Learning Network, 7(1).
Rosenberg, M.J. (2001). E-learning Strategies for Delivering Knowledge in the Digital Age. New York: McGraw-Hill.
Saleh, I., & Kim, S. I. (2009). A fuzzy system for evaluating students' learning achievement. Expert Systems with Applications, 36(3), 6236-6243.
Sandars, J., and Langlois, M. (2005). E-learning and the Educator in Primary Care: Responding to the Challenge. Education for Primary Care, 16,129-133.
Sanjay, V., Ramachandran, M. (2006). Multicriteria evaluation of demand side management (DSM) implementation strategies in the Indian power sector. Energy 31 (12), 2210–2225.
Sezhian, M.V., Muralidharan, C., Nambirajan, T., Deshmukh, S.G. (2011). Performance measurement in a public sector passenger bus transport company using fuzzy TOPSIS, fuzzy AHP and ANOVA – a case study.International Journal of Engineering Science and Technology (IJEST) 3 (2), 1046 1059.
Smith, H. (2009). Asynchronous online instruction: Generation and validation of a program evaluation instrument. Pd.D. dissertation, Pepperdine University, United States -- California. Retrieved January 30,2010, from Dissertations & Theses: Full Text. (Publication No. AAT 3355858).
Soheil, S.N., Kaveh, K.D. (2010). Application of a fuzzy TOPSIS method base on modified preference ratio and fuzzy distance measurement in assessment of traffic police centers performance. Applied Soft Computing 10 (4), 1028– 1039.
Stiggins, R.J. (2006, November/December). Assessment for learning: A key to motivation and achievement. Phi Delta Kappa International, 2(2), 1-19.
Sun, C.-C. (2010). A performance evaluation model by integrating fuzzy AHP and fuzzy TOPSIS methods. Expert Systems with Applications, 37(12), 7745-7754. doi: http://dx.doi.org/10.1016/j.eswa.2010.04.066.
Tham, C. M., & Werner, J. M. (2005). Designing and evaluating e-learning in higher education: A review and recommendations. Journal of leadership & organizational studies, 11(2), 15-25.
Tomcho, T. J., & Foels, R. (2008). Assessing effective teaching of psychology: A meta-analytic integration of learning outcomes. Teaching of Psychology, 35, 286-296.
Urdan, T. A., & Weggen, C. C. (2000). Corporate e-learning: Exploring a new frontier. WR Hambrecht Co.
Vaidya, O. S.; Kumar, S. (2006). Analytic hierarchy process: An overview of applications. European Journal of Operational Research, v. 169, n. 1, p. 1–29, fev.
Van Laarhoven, P. J. M., & Pedrycz, W. (1983). A fuzzy extension of Saaty's priority theory. Fuzzy Sets and Systems, 11(1–3), 229–241.

Wu, W.-W., & Lee, Y.-T. (2007). Developing global managers' competencies using the fuzzy DEMATEL method. Expert Systems with Applications, 32(2), 499–507.

Yang, Y., & Lin, N.C. (2010). Internet perceptions, online participation and language learning in Moodle forums: A case study on nursing students in Taiwan. Procedia Social and Behavioral Sciences, 2.

Yu, C. S. (2002). A GP-AHP method for solving group decision-making fuzzy AHP problems. Computers and Operations Research, 29(14), 1969-2001.

Zadeh, L. A. (1965). Fuzzy sets. Information and control, 8(3), 338-353.

Zadeh, L.A. (1975). The concept of a linguistic variable and its application to approximate reasoning – I. Information Sciences 8 (3), 199 249.