Multi-dimensional students' evaluation of e-learning systems in the higher education context: An empirical investigation

Sevgi Ozkan *, Refika Koseler
Informatics Institute, Middle East Technical University, Ankara, Turkey

ABSTRACT
There has been little research on assessment of learning management systems (LMS) within educational organizations as both a web-based learning system for e-learning and as a supportive tool for blended learning environments. This study proposes a conceptual e-learning assessment model, hexagonal e-learning assessment model (HELAM) suggesting a multi-dimensional approach for LMS evaluation via six dimensions: (1) system quality, (2) service quality, (3) content quality, (4) learner perspective, (5) instructor attitudes, and (6) supportive issues. A survey instrument based on HELAM has been developed and applied to 84 learners. This sample consists of students at both undergraduate and graduate levels who are users of a web-based learning management system, U-Link, at Brunel University, UK. The survey instrument has been tested for content validity, reliability, and criterion-based predictive validity. The analytical results strongly support the appropriateness of the proposed model in evaluating LMSs through learners’ satisfaction. The explanatory factor analysis showed that each of the six dimensions of the proposed model had a significant effect on the learners’ perceived satisfaction. Findings of this research will be valuable for both academics and practitioners of e-learning systems.

1. Introduction
The traditional context of learning is experiencing a radical change. Teaching and learning are no longer restricted to traditional classrooms (Wang, Wang, & Shee, 2007). Electronic learning (hereafter e-learning), referring to the use of electronic devices for learning, including the delivery of content via electronic media such as Internet, audio or video, satellite broadcast, interactive TV, CD-ROM, and so on (Kaplan-Leiserson, 2000), has become one of the most significant developments in the information systems (hereafter IS) industry (Wang, Liaw, & Wang, 2003). The rapid expansion of the Internet as a delivery platform, combined with the trends towards location-independent education and individualization, has motivated universities to invest their resources on developing online programs. However, the development, management and continuous improvement of e-learning systems are quite challenging both for the educational institutions and for the industry. In that, assessment has become an essential requirement of a feedback loop for continuous improvement: ‘What gets measured gets attention’ (Eccles, 1991).

E-learning systems are multidisciplinary by nature. Many researchers from fields such as computer science, information systems, psychology, education, and educational technology, have been trying to evaluate e-learning systems. Some have focused on technology-based components of e-learning systems (Islas et al., 2007), where others have studied only the human factor of e-learning systems considering student and instructor satisfaction (Liaw, Huang, & Chen, 2007). Douglas and Van Der Vyver (2004) dealt with the effectiveness of e-learning course materials only; where Arbaugh and Fich (2007) studied the importance of participant interaction in online environments; and Gilbert (2007) investigated the student experience perspective only. These individual assessment frameworks yield convenient solutions in practice. However, they comply with the needs only partially not fulfilling all of the necessities.

The purpose of this research is to develop a comprehensive e-learning assessment model using existing literature as a base, incorporating concepts from both information systems and education disciplines. This study contributes to the e-learning literature with an instrument providing guidelines for e-learning systems developers and distance educators to better understand the students’ perceptions of both social and technical issues associated with e-learning systems. By providing a multidimensional evaluation of e-learning systems from...
students’ perspective, the findings of this research help to build more effective learning management systems and improve effectiveness in distance education.

The paper is organized as follows. First, a critical review of a number of approaches of e-learning assessment from social and technical perspectives is presented. From this review, components that constitute a conceptual model for e-learning systems assessment have been developed. Next, the proposed model and the survey instrument are described. Further, the empirical investigation where the survey instrument is applied on a learning management system at a higher education institution is reported. The survey instrument has been tested on learners for content validity, reliability, and criterion-based predictive validity. The explanatory factor analysis has been conducted. The findings are discussed and compared with the literature. Finally, contributions of this research are summarized. Based on these issues for the utilization of the research contributions in terms of potential future research topics are addressed.

2. Literature review

Volery and Lord (2000) defined e-learning as a combination of learner, faculty, instructor, technical staff, administrative, learner support, and use of the Internet and other technologies. In parallel, the success of an e-learning system may be considered as an emerging concept of ‘social issues’ and ‘technical issues’ and depends on numerous circumstances, rather than a black-and-white formula. e-Learning systems are open systems so they are affected by the environment and influenced by the people who use them. Since e-learning systems are socio-technical entities, the e-learning literature has been reviewed under two sections in the following paragraphs.

2.1. e-Learning system as a social entity

It is evident from previous research that the quality of an instructor is an important determinant for an effective learning management system (hereafter LMS) (Hiltz, 1993; Islas et al., 2007; Khan, 2005; Liaw et al., 2007; Selim, 2007; Wang et al., 2007; Webster & Hackley, 1997). Liaw et al. (2007) claimed that, ‘instructor’ is the major aspect of e-learning. Within learning environments, instructors should have enough time to interact with students in their learning process (Khan, 2005). In parallel, Collins (1995) emphasizes the importance of the ‘instructor’ highlighting the fact that it is not the technology itself but the instructional implementation of the technology which determines its effects on learning. Similarly, Webster and Hackley (1997) state that instructors’ attitudes towards a technology, their teaching styles, and their control over the technology affect the learning outcomes. Moreover, Dillon and Gunawardena (1995) suggested that instructors’ attitudes towards technology-mediated distance learning systems should be considered when evaluating these systems.

Several researchers considered learner’s perceived effectiveness as an important indicator of an effective LMS (Piccoli, Ahmad, & Ives, 2001; Webster & Hackley, 1997; Dillon & Gunawardena, 1995; Leidner & Jarvenpaa, 1993; Islas et al., 2007; Kim & Lee, 2007; Liaw et al., 2007; Volery & Lord, 2000; Holsapple & Lee-Post, 2006; Selim, 2007; Sun, Tsai, Finger, Chen, & Yeh, 2008). In that, interactive instructional design is proved to be an essential factor for learning satisfaction and success (Hong, Lai, & Holton, 2003; Arbaugh, 2002; Berge, 2000; Jiang & Ting, 1998; Khan, 2005; Levy, 2007; Shee & Wang, 2008). As a need, understanding and identifying the attitudes of learners towards the LMS is important when investigating learner’s satisfaction. In order to design effective e-learning environments, it is necessary to ‘understand the target group’ (Liaw et al., 2007). Learner characteristics such as motivation, belief, confidence, computer anxiety, fear, anxiety, apprehension, enthusiasm, excitement, pride and embarrassment need to be identified (Konradt & Sulz, 2001; Passerini & Granger, 2000). Moreover, perceived enjoyment, and usefulness are positively related to intention to use LMS (Liaw et al., 2007).

There are other issues such as trends, ethical and legal issues, environmental issues, i.e., technological developments, popularity of LMS tools, which have significant impacts on the effectiveness of an LMS. Khan (2005) pointed out the importance of ethical and legal issues on LMS success.

2.2. e-Learning system as a technical entity

In addition to social issues mentioned, there are technical issues such as system quality and Internet quality, that have a significant effect on the effectiveness of an LMS (Dillon & Gunawardena, 1995; Kim & Lee, 2007; Leidner & Jarvenpaa, 1993; Islas et al., 2007; Piccoli et al., 2001; Webster & Hackley, 1997; Liaw et al., 2007; Volery & Lord, 2000; Holsapple & Lee-Post, 2006; Selim, 2007; Sun et al., 2008). System quality has two components: the LMS software and the peripherals, i.e., the hardware. The software quality involves stability, security, reliability, pace, responsiveness, ease of use, user-friendliness, well-organized design, personalization (Shee & Wang, 2008). The quality of the peripherals involves wellness of microphones, earphones, electronic blackboards, electronic mail, online threaded discussion boards, synchronous chat, and desktop videoconferencing. The higher the quality and reliability of used technology, the higher the learning effects will be (Hiltz, 1993; Piccoli et al., 2001; Webster & Hackley, 1997; Sun et al., 2008).

In recent years, several innovative Internet technologies such as Web 2.0 applications have been applied in the development of e-learning systems. One of the most popular outcomes of Web 2.0 technologies are Personalized Learning Environments (PLEs) (Weller, 2006). When Web 2.0 principles were analyzed from a learning perspective, Ullrich et al. (2008) highlighted stimulation of active participation, i.e., interactivity; and interactive content as distinguished features.

Content quality in e-learning depends on how well the learning environment is designed and managed. Learners place great value on content where a quality content is well-organized, effectively presented, interactive, clearly written, in the right length, useful, flexible, and provide appropriate degree of breath (Shee & Wang, 2008). Holsapple and Lee-Post in their study (2006) highlighted the importance of up-to-datedness and usefulness of the content. In addition, effective course management, i.e., entering grades in time, making necessary announcements on time, pre-defined structured exam evaluation criteria, enables learners to feel more comfortable with the course content, resulting in higher retention and satisfaction rates.

Other issues when delivering courses via an LMS can be grouped under service quality, which includes administrative affairs such as, student tracking, course/instruction authorization, providing LMS design tools, course management, budgeting, institutional funding and resources for delivering and maintenance.
A number of issues related with the effectiveness of an LMS have been reviewed. These have been summarized in Appendix A. The following section develops a comprehensive e-learning assessment model using existing theory as a base.

3. Method


Most research suggests an integrated approach to the assessment of e-learning systems. Related literature has been reviewed focusing on e-learning systems both as a ‘social’ and a ‘technical’ entity. Based on the literature, the social and technical issues related with LMS assessment have been summarized in a table presented in Appendix A. It has been observed that individual assessment models examined yield convenient solutions in practice within their specific contexts and are in conformance with the complementary literature. However, for effective e-learning, there is a need for a systematic and comprehensive evaluation model which comprises both social and technical issues of e-learning. In this respect, a hexagonal e-learning assessment model (HELAM) is proposed for LMS assessment. There are 47 criteria grouped under six dimensions as illustrated in Fig. 1. This model is not LMS specific and it is applicable to various e-learning information systems. It is important to note that HELAM is neither a fixed nor a universal model.

3.2. Survey instrument and data collection

In this study both quantitative and qualitative methods have been used to test the proposed model, HELAM. To collect data from students about their perceptions of the blended learning environment and LMS in regards to their benefits and satisfaction level; a survey instrument based on HELAM has been developed. The researchers referred to a group of experts when discussing the validity of the questions within the survey instrument. The aim was to conduct a content validity based on the extent to which the measurement reflects the specific intended domain of content (Carminnes & Zeller, 1994). A total number of ten experts in the field of information systems (IS) and educational technology have been asked to assess whether each dimension in the model is ‘essential’, ‘useful but not essential’, or ‘not necessary’. Four of the experts are from the Information Systems Evaluation and Integration Group (ISEing), Brunel University, London, UK; two from Learning and Teaching Development Unit, Brunel University, London, UK; and two from the Middle East Technical University, Informatics Institute, Ankara, Turkey, and two from the Computer Education and Instructional Technology Department, Middle East Technical University, Ankara.

A pilot study was conducted where the initial instrument was applied to 90 undergraduate Level 1 students who were enrolled with the course entitled “IS100 Introduction to Information System Technologies and Applications” at Middle East Technical University, Turkey. The
LMS evaluated was METU-online (Ozkan, Koseler, & Baykal, 2009). Together with the findings from this pilot study and the feedback gained from the individual experts, both HELAM and the survey instrument had been revised and developed iteratively.

The final version of the survey consists of 73 questions in two main parts: first part aims to gather generic data about the learners, and the second part about learners’ LMS experiences. The first part consists of demographic questions. The second part is divided into six sections each of which corresponds to one HELAM dimension. In this part, five point likert-type scale item is used. These questions are anchored from 1 to 5, where 1 indicates strong disagreement and five indicates strong agreement. All responses were guaranteed confidentiality. The survey instrument is presented in Appendix A. For quantitative data collection, the survey instrument has been made available online. It has been anticipated that the use of computer-assisted data collection can greatly improve the reliability of the data as it eliminates the human data entry step that includes some natural human errors (Fowler, 1993).

In order to capture qualitative data, focus group discussions have been conducted with 20 e-learners. Four different focus groups were formed randomly from volunteers who were enthusiastic to become a part of this study. Each group consisted of 5 e-learners at graduate and undergraduate levels. Approximately 30 min were spent with each group. The focus groups created an interactive group setting where participants felt free to talk with other group members and make critiques. Semi-structured questions were asked seeking learner’s general beliefs, perceived satisfaction, attitudes, and comments about the instructor, course, and the LMS.

3.3. Participants

The survey instrument was sent out to a total of 265 individuals. This sample consists of both graduate and post-graduate students at Brunel University, UK. All respondents are active users of U-Link as a supportive tool to the courses they are enrolled. The online survey was conducted for one month, with incomplete responses and missing values deleted, resulting in a sample size of 84 users for an overall response rate of 32%. Responses were voluntary and therefore unavoidably subject to self-selection biases. Conceivably, users who were interested in using e-learning were more likely to respond. Table 1 lists the respondents’ demographic characteristics, including gender, age and computer usage.

4. Statistical analyses

To examine the data, statistical methods have been used. Descriptive statistics were run to analyze the collected data. The responses to the questionnaire were analyzed using the Statistical Package for the Social Sciences (SPSS) 11.5 Windows software program. In order to validate the proposed LMS evaluation model, HELAM and the survey instrument, a number of validity and reliability tests have been applied. An explanatory factor analysis was conducted to examine the factor structure of the survey instrument. Reliability was evaluated by assessing the internal consistency of the items representing each factor using Cronbach’s alpha. Finally, criterion-based validity was tested.

4.1. Identifying factor structure

Before the factor analysis; we scanned for the significance correlation values and looked for any item for which the majority of the values are greater than the alpha value 0.05. Then the researchers searched for any value among the correlation coefficients that are greater
than 0.9 to avoid any possible multicollinearity problem. Checking the determinant of the correlation matrix is another way of detecting multicollinearity problem. In our case the majority of the correlation coefficients are significant along with values smaller than 0.9 and a determinant greater than the necessary value of 0.00001, therefore all the questions left1 in our survey instrument correlate reasonably well and none of them is particularly large not leading to multicollinearity or singularity.

Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy and Bartlett’s test of Sphericity was conducted and a KMO value of 0.861 was found. A value close to one indicates that of correlations are relatively compact and so factor analysis should yield distinct and reliable factors (Kaiser, 1974). Therefore we can make an inference such that there are separate differences between factors’ correlations indicating having an adequate sample along with distinct reliable factors. In addition we have a significant test with Chi Square value of 2309.62 with 63 degrees of freedom and a significance value of 0.000 therefore we can conclude there are non-zero correlations between variables hence factors exist.

Explanatory factor analysis was conducted to primarily establish the factor structure of the model. In order to investigate the internal consistency of the subscales of the survey, Cronbach’s alpha coefficient was examined. Descriptive statistics were used to present central tendency and variability. In order to decide the number of factors we used Screen plot and Eigenvalues greater than 1 criterion (Tabachnick & Fidell, 2007). It was found that items were loaded on exactly six factors named as: Instructor Quality (Factor 1), information content quality (Factor 2), system quality (Factor 3), service quality (Factor 4), learner’s attitude (Factor 5) and finally supportive issues (Factor 6). Total explained variance by running the data was 63.09%. This percentage is high enough to consider HELAM survey instrument as successful.

Table 2 summarizes the factor loading of the survey instrument. Rotation optimizes the factor structure as a result the relative importance of the six factors is equalized and construction Rotated Component Matrix we have reached more homogenously distributed factor loadings of items among six factors.

### 4.2. Reliability

In order to determine the reliabilities of the factors and to assess the internal consistency of the factors, we used Cronbach’s alpha. All the factors have high values of Cronbach’s alpha that can be seen from Table 2, all of which are around 0.8 being close to one. Since

---

1 All the steps explained through factor analysis contains repeated controls for omitting inappropriate items from the factors in according to the factor analysis rules explained throughout this part. The process is defined over the final version of the factors.
Cronbach’s alpha evaluates how well the items of a factor measure a single unidimensional latent construct; a high value closer to one indicates that the items consisting the factor can measure the same underlying structure meaning they form a reliable factor and they are consistent in between the other items in the factor.

4.3. Criterion-based predictive validity

Regarding predictive validity, a multiple regression analysis was performed. The main objective was to assess the efficacy and effectiveness of the survey instrument’s parameters in predicting learner’s satisfaction. In this research, the proposed usability parameters (i.e., the six factors identified in factor analysis) are the independent variables (IVs) and the composite variable learner satisfaction is the dependent variable (DV). The composite dependent variable consisted of three items used to measure learner satisfaction. All independent variables were entered into the analysis simultaneously in order to assess the predictive strength of the proposed model. When all independent variables were entered into the multiple regression model, results showed an $R$ square of 0.982 and adjusted $R$ square of 0.963 (Table 3) at $p < 0.002$ which is statistically significant. These findings accounted for 96.4% (adjusted $R$ square 92.7%) of the variance in learner’s satisfaction, which delineate good results for the survey instrument and can be considered as preliminary evidence of its validity (Cohen, 1988).

5. Results

Descriptive statistics of each HELAM category are depicted in Table 4 to summarize the data collected from survey results. These include mean, maximum, minimum values and standard deviations. Based on the descriptive statistical data, learner’s perceived satisfaction from U-Link is high (mean value 3.72).

In addition to descriptive statistics, Pearson correlations have been reported for all quantitative measures in order to test the quantitative results. All findings have been analyzed with Pearson correlation coefficient at the significant level of 0.01. The findings were not accepted if the significant level (2-tailed) was less than 0.01. The results of testing Pearson correlation coefficient values are shown in Table 5. By using Pearson’s product moment coefficient values interpretation has been done in two ways: one is by looking into correlations of each HELAM dimension with overall student satisfaction, and by examining correlations between dimensions. The latter is out of the scope of this study.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>LMS success parameters in predicting learner’s satisfaction.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model summary</td>
<td>$R$</td>
</tr>
<tr>
<td>1</td>
<td>0.982*</td>
</tr>
</tbody>
</table>

* Predictors: (constant), Factor 1: instructor Quality; Factor 2: information content quality; Factor 3: system quality; Factor 4: service quality; Factor 5: learner’s attitude; Factor 6: supportive issues.

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Descriptive statistics: mean, standard deviation, maximum and minimum values for HELAM dimensions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Minimum</td>
</tr>
<tr>
<td>Learner’s attitudes</td>
<td>84</td>
</tr>
<tr>
<td>Instructor quality</td>
<td>84</td>
</tr>
<tr>
<td>System quality</td>
<td>84</td>
</tr>
<tr>
<td>Information quality</td>
<td>81</td>
</tr>
<tr>
<td>Service quality</td>
<td>84</td>
</tr>
<tr>
<td>Supportive issues</td>
<td>84</td>
</tr>
<tr>
<td>Total learning quality</td>
<td>83</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Correlations between the categories of the survey instrument (corresponds with HELAM dimensions).</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>1</td>
</tr>
<tr>
<td>Overall satisfaction (1)</td>
<td>1</td>
</tr>
<tr>
<td>Learner’s attitudes (2)</td>
<td>0.482**</td>
</tr>
<tr>
<td>Instructor quality (3)</td>
<td>0.602**</td>
</tr>
<tr>
<td>Supportive issues (4)</td>
<td>0.630**</td>
</tr>
<tr>
<td>Information quality (5)</td>
<td>0.623**</td>
</tr>
<tr>
<td>System quality (6)</td>
<td>0.753**</td>
</tr>
<tr>
<td>Service quality (7)</td>
<td>0.537**</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed).
Pearson’s product moment coefficient ($r$) is a parametric technique which portrays the strength and direction of the relationships between two variables. A correlation coefficient was also perceived as a statistical devise used to measure the strength/degree of supposed linear relationships between two variables. It is said to take the value from $-1$ to $+1$. The sign in front denotes the nature of the relationship and the absolute figure provides an indication of the strength of the relationship. The interpretation of the value between 0 and 1 was according to Cohen (1988) guidelines as follows, $r = 0.10$–0.29 or $r = 0.0$–$-0.10$ to $-0.29$ is indicated as small, $r = 0.30$–0.49 or $r = -0.30$ to $-0.49$ is indicated as medium and lastly, $r = 0.50$–1.0 or $r = -0.50$ to $-1.0$ is in the scope of large. The level of criticality of each dimension is represented by its Pearson correlation results.

In addition to statistical analyses, findings from the focus group interviews were analyzed. A total of 20 learners expressed their opinions, where all respondents were volunteers. These qualitative findings support the quantitative analyses. In the following paragraphs, discussions on findings are presented where statistical results (Tables 4 and 5) have been merged with qualitative findings, which altogether are supported by the literature.

6. Discussion

The first dimension identifies the effect of learner attitudes on perceived learner’s satisfaction from LMS. Statistical results (Tables 4 and 5) prove that there is a positive statistically significant relationship between learner’s attitudes and overall learner satisfaction. This is in parallel with the literature where Webster and Hackley also (1997) stated that learner’s attitudes towards technology and blended learning may have significant effects on the success of the LMS. However, in this study, ‘learner’s attitudes’ has not been found to be the most significant factor on user satisfaction, which is in contrast with some researchers who proposed that user satisfaction is the most appropriate measure for IS success available (Davis, Bagozzi, & Warshaw, 1989; Gelderman, 1998; Zoltan & Chapanis, 1982). The most powerful indicator for learner’s attitudes has been found to be ‘learner’s perceived enjoyment towards e-learning system’ ($r = 0.782; p = 0.01$). This is in parallel with quantitative findings: one learner stated that “…U-Link is beneficial for me mainly because I can achieve the whole course material whenever and wherever I want. Besides, the course materials are spread electronically not in paper format via U-Link that I can save important course materials during even after the semester without any loss of information. Additionally, the electronic format of the course materials helps me to achieve these important files more easily and efficiently. I can even save my whole course materials years and years…” This is a highly important factor, which changes learner’s attitudes positively toward LMS. Most of the participants stated that they would still prefer to use U-Link as a supportive tool even if it was optional as they believe that it would help their performance in the module. Another finding from the focus group interviews supported by the statistical results is that the attitudes of learners towards U-Link are positively related with the learner’s past LMS experience. For instance, one post-graduate learner stated that “…since I am familiar with distance learning from my undergraduate studies, I found it straightforward to use U-Link. It was not difficult for me to find the relevant tools of U-Link…”

The second dimension identifies the effect of instructor quality on perceived learner’s satisfaction from the LMS. Statistical results (Tables 4 and 5) prove that there is a strong relationship between the instructor’s quality and learner’s perceived satisfaction. Collis (1995) remarked that the instructor plays a central role in the effectiveness of online delivery: “It is not the technology but the instructional implementation of the technology that determines the effects on learning”. In parallel, focus group discussions have strengthened the importance of instructors. One of the learners stated that, “…whenever I send an e-mail to instructor or write something on forum, I more enthusiastically open my U-Link session because I wonder the answer, but if the instructor does not reply to my question, my willingness to login U-link session decrease dramatically…” Another learner states “…the instructor is very friendly and his methods were admired which motivates me to use U-Link…” In brief, learner’s perceived satisfaction towards e-learning is positively affected when the instructor responds to learners rapidly, his teaching style is good enough, and his explanations are clear, and when he has control over technology; which altogether influence the success of the learning overall positively. These results overlap with the literature (Arbaugh & Duray, 2002; Thurmond, Wambach, & Connors, 2002).

The third dimension identifies the effect of system quality on learner’s perceived satisfaction. Statistical results (Tables 4 and 5) prove that there is a highly positive relationship between system quality of the LMS and overall learner satisfaction. Considering the criteria under the system dimension, it can be deduced that the stability of the learner interfaces has a significant emphasis on the learner. The focus group discussions explored that the user interface is an area where a high level of interaction takes place; a well-designed, user-friendly learner interface becomes one of the most critical factors in determining the satisfaction of learners when using the LMS. This is in parallel with many IS-related studies (DeLone & McLean, 2003; Laudon & Laudon, 2000; Arbaugh & Fich, 2007; Wang et al., 2007; Seddon, 1997). Another key issue which has been gaining importance with the development of Web 2.0 technologies in education is personalization (Weller, 2006). One of the learners stated that “…when I login, I feel more organized seeing an opening page with my personal details… it is nice when it warns me which announcements I have not read… ”. The focus group interviews reflect that one of the most important requirements of the learners is being able to control their learning progress. The learner’s habits have also been found to affect the overall LMS success. ‘Easy navigation’, ‘easy to find the required information’, and ‘available help option’ are important aspects for creating learner’s habit. Another outcome of Web 2.0 technology applications in education is interactivity (Mason & Rennie, 2007). Before Web 2.0, students often felt isolated in a distance environment since they were not able to interact with the instructor and other students. Both quantitative ($r = 0.792; p = 0.01$) and qualitative results of this study prove that interactivity is an essential component in both blended and online learning.

The fourth dimension identifies the effect of information (content) quality on learner’s perceived satisfaction. Statistical results (Tables 4 and 5) prove that there is a strong positive relationship between information quality of the LMS and overall learners’ perceived satisfaction. Focus group interviews support that course quality has a significant role on learner’s perceived satisfaction from LMS. Learner’s mostly define a quality content as whether the presentations or lecture notes are easily understandable, used appropriate degree of breath, up-to-date, and rich content. Additionally, they state that, clear examples, illustrations, given additional resources gain their attentions, and positively influence their satisfaction. Quantitative results prove that interactive content is significant in both blended and online learning ($r = 0.783; p = 0.01$). This is in parallel with the literature where Web 2.0 technologies provide interactive online content (Safran, Helic, & Gütl, 2007).
The fifth dimension identifies the effect of **service quality** on learner’s perceived satisfaction. Statistical results (Tables 4 and 5) prove that there is a positive relationship between service quality of the U-Link and overall satisfaction. Learners are highly satisfied by the assistants’ attitudes, and the services provided by the administrative staff. Focus group results show that learners in blended learning courses often face technical problems which influence their overall satisfaction level negatively. It is therefore crucial that every blended learning program has to have a supportive technical staff who has a good control of the technology and who is able to perform basic troubleshooting tasks such as adding a learner at the last minute, modifying learner’s passwords, changing the course settings, etc. (Volery & Lord, 2000). Another result is that learner’s perceived satisfaction is positively related to the capability of service provided to follow up student problems and to solve students’ problems. In parallel with Haynes, Pouroghabagher, and Seu (1997) supportive staffs are essential for overall coordination of a blended learning module. Both faculty and technical resources must be identified and committed to the schedule during the development of a blended module (Volery & Lord, 2000).

The sixth dimension identifies the effect of **supportive issues** on learner’s perceived satisfaction. Statistical results (Tables 4 and 5) prove that there is a strong positive relationship between supportive issues and overall learner satisfaction. Qualitative results demonstrate that, popularity of LMS and trends influence LMS users significantly. For instance, U-Link was developed back in 1999. Since 1999, at the beginning of each term, all the university students and academics have been encouraged to use U-Link in their modules. According to the statistical data provided by the Brunel University, the use of U-Link has increased significantly during the last three years. According to one of the U-Link developers (David Sacramento) this is mainly because of the increasing popularity of e-learning portals. Another important indicator for LMS effectiveness can be named as "friend effect". One of the learners stated “one of my friends in the upper class advised me to check my announcements on U-Link, otherwise I wouldn’t use it. . . . now I am regularly checking . . ." The ‘supportive issues’ dimension additionally covers ethical and legal issues together with privacy, plagiarism and copyright concepts. Khan (2005), in his book, emphasized the importance of ethical and legal issues to create an effective LMS. In a typical e-learning module, there are numerous text dialogs generated from LMS communication tools (e-mail, forum). These communication tools contain participants’ personal views and biases which they may not want the outside world to know. Considering the openness of the web, search engines can find this information. Therefore, institutions should clearly indicate to the learners whether or not their personal information will be shared. e-learning module should provide clear information regarding institution’s plagiarism policy. Important e-learning portals impose serious penalties if a case of plagiarism is substantiated (Athabasca University in Canada, Phoenix University in USA, Open University in UK). The last ethical–legal issue is copyright. Content authors, instructors, tutors, facilitators and other learning material developers should consider the others intellectual property rights during the preparing e-learning materials and institutes should check the copyright infringements (Papp, 2000).

7. Conclusions

This study attempted to propose an e-learning evaluation model comprising a collective set of measures associated with an e-learning system. The research in this paper sought to empirically test the constructs of this proposed conceptual model via a survey instrument and to demonstrate which were critical for e-learning systems effectiveness. The instrument was validated and it has been proved that all six dimensions of the proposed e-learning evaluation model were important for e-learning effectiveness.

Even though the statistical analyses and pertinent literature allowed the researchers to propose a comprehensive LMS evaluation model, it is important to note that this instrument focuses on assessing the effect of each HELAM dimension on overall e-learning perceived satisfaction based on **student perceptions only**. However, there are other stakeholders of e-learning systems such as system developers, technicians, administrators, instructors, instructional designers, multimedia designers, online facilitators, independent evaluators, etc. whose perceptions are also important indicators for a complete e-learning systems evaluation. In this study, a survey instrument based on HELAM with respect to student perceptions has been developed, verified and validated. For future work, HELAM could be taken as a basis forming a starting point when developing other instruments for e-learning systems evaluation with respect to other stakeholders’ perceptions.

However, as DeLone and McLean (2003) emphasize, information systems success is a multidimensional and interdependent construct, and it is therefore necessary to study the interrelationships among those dimensions. Hence future research efforts should explore and test the causal relationships among proposed dimensions within the boundary of e-learning. Another future expansion would be to check the validity of the causal research model on different learning management systems.

The proposed model (HELAM) is not exhaustive and is open to continuous development. It is not a fixed and unchanged model. Future studies may extend this model through adding other dimensions or criteria in parallel with changes in the e-learning field and with the latest advances in e-learning technologies. In this regard, HELAM is composed of fundamental issues which should be perceived as very basics for effective e-learning.

Future research may focus on the development of other instruments based on HELAM specific to various types of organizations that reflects the characteristics of education and training practices taking place in different institutional settings, including primary and secondary schools, universities and companies. In conclusion, 47 measures grouped under six dimensions for evaluating e-learning systems can greatly benefit those engaged in e-learning as they seek guidance to better understand how e-learner’s perceived satisfaction can be increased and how the use of learning management systems can be improved.

Acknowledgement

This research has been partially funded by the Scientific Research Projects (BAP) Funding Center of Middle East Technical University, Ankara, Turkey.
<table>
<thead>
<tr>
<th>HELAM dimensions</th>
<th>Measures</th>
<th>Pertinent literature</th>
<th>Survey instrument question number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A2. Trends (social-political)</td>
<td>Khan (2005)</td>
<td>69, 70</td>
</tr>
<tr>
<td></td>
<td>A3. Ethical issues</td>
<td>Khan (2005)</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>B3. Self efficacy</td>
<td>Piccoli et al. (2001), Zaharias and Poulymenakou (2003), Granic (2008), Hiltz and Johnson (1990), Sun et al. (2008)</td>
<td>10, 12, 13, 15</td>
</tr>
<tr>
<td></td>
<td>B7. Student experience level with LMS</td>
<td>Rosenberg (2006)</td>
<td>18</td>
</tr>
<tr>
<td><strong>C. Instructor’s attitudes</strong></td>
<td>C1. Responsiveness</td>
<td>Sun et al. (2008)</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>C2. Informativeness</td>
<td>Shumarova and Swatman (2007), Sun et al. (2008)</td>
<td>19, 23</td>
</tr>
<tr>
<td></td>
<td>C3. Fairness</td>
<td>Levy (2007)</td>
<td>19, 29</td>
</tr>
<tr>
<td></td>
<td>C5. Control over technology</td>
<td>Volery and Lord (2000), Webster and Hackley (1997)</td>
<td>21, 22, 26</td>
</tr>
<tr>
<td><strong>D. System quality</strong></td>
<td>D1. Easy to use</td>
<td>Sun et al. (2008), Shee and Wang (2008), Holsapple and Lee-Post (2006)</td>
<td>36, 37</td>
</tr>
<tr>
<td></td>
<td>D2. Security</td>
<td>Holsapple and Lee-Post (2006)</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>D4. Usability</td>
<td>Piccoli et al. (2001); Dillon and Gunawardena (1995)</td>
<td>40, 44, 38</td>
</tr>
<tr>
<td></td>
<td>D5. Maintenance</td>
<td>Martinez-Torres et al. (2008), Wu et al. (2008); Shee and Wang (2008)</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>D6. Help option available</td>
<td></td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>D11. Interactivity</td>
<td>Islas et al. (2007), Khan (2005); Webster and Hackley (1997)</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>E2. Course flexibility</td>
<td>Sun et al. (2008)</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>E3. Interactive content</td>
<td>Piccoli et al. (2001)</td>
<td>52, 53</td>
</tr>
<tr>
<td></td>
<td>E4. Learning model</td>
<td>Piccoli et al. (2001)</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>E5. Tutorial quality</td>
<td>Littlejohn, Falconera, and McGillib (2008), Webster and Hackley (1997)</td>
<td>59, 57, 60</td>
</tr>
<tr>
<td></td>
<td>E6. Clarity</td>
<td>Holsapple and Lee-Post (2006)</td>
<td>55, 57, 60</td>
</tr>
<tr>
<td></td>
<td>E7. Sufficient content</td>
<td>Holsapple and Lee-Post (2006)</td>
<td>49, 50</td>
</tr>
<tr>
<td><strong>F. Service quality</strong></td>
<td>F1. Student tracking</td>
<td>Volery and Lord (2000), Islas et al. (2007))</td>
<td>61, 62, 65</td>
</tr>
<tr>
<td></td>
<td>F2. Course/instruction authorization</td>
<td>Islas et al. (2007)</td>
<td>64</td>
</tr>
</tbody>
</table>
Appendix B. Helam survey instrument

B.1. Demographic questions

1. Please enter your age.
2. Please enter your sex.
3. Average time I spend on using a computer/Internet per day.
4. Average time I spend on using a computer/Internet for educational purposes per day.
5. Average time I spend on using U-Link per day is.

B.2. Overall

6. U-Link helps me to manage my learning more systematically.
7. Overall, I am satisfied with U-Link.
8. Overall, I find U-Link successful.

B.3. Learner’s perspective

9. Face-to-face education is better than distance education in learning process.
10. I can manage my “study time” effectively and easily complete assignments on time by using U-Link.
11. I enjoy attending to the U-Link sessions overall.
12. U-Link improves my success in the module.
13. I find all my educational need from U-Link.
14. U-Link makes the communication easier with instructor and other class mates for me.
15. In my studies, I am self-disciplined and find it easy to set aside reading and homework time.
16. I believe that U-Link is a very efficient educational tool.
17. U-Link helped me to become more familiar with the module.
18. I have previous experience with LMS.

B.4. Instructor attitudes

19. Instructor clearly informs the students about grading policy via U-Link.
20. The instructor returns e-mails/posts within 24 h via U-Link.
21. The instructor follows up student problems and tries to find out solution via U-Link.
22. Instructor frequently updates lecture notes and fixes all the errors and mistakes in the documents on the U-Link.
23. The instructor responds promptly to questions and concerns via U-Link.
24. The instructor is proficient with all the content used in the course.
25. The instructor created an online environment conducive and enjoyable for learning via U-Link.
26. The instructor is good at communicating with students via U-Link.
27. I think communicating with the instructor via U-Link is important and valuable.
28. I find it easy to communicate with the instructor via U-Link.
29. Exam and assignment results are announced on time via U-Link.
30. The instructor encourages us to interact with other students by using U-Link interactive tools.

B.5. System quality

31. U-Link’s graphical user interface is suitable for e-learning systems.
32. The program directions and navigations are clear.
33. U-Link supports interactivity between learners and system by chat, forums, discussions, etc.
34. I have not faced any system errors on U-Link.
35. When I counter an error in the system, I can get immediate feedback by e-mail and telephone.
36. Navigation is very easy on U-Link.
37. I can find required information easily on U-Link.
38. In the U-Link system I can easily navigate where I want.
39. U-Link is easily accessible via Internet.
40. U-Link is a good educational portal and improves my learning.
41. Help option is available on the system.
42. U-Link is accessible 7 days 24 h.
43. I am informed about all the course announcements U-Link by using ‘announcements’ tool.
44. Fonts (style, color, and saturation) are easy to read in both on-screen and in printed versions.
45. When I log in, I prefer U-Link to provide me a personalized entry page (i.e., showing my progress, showing which chapters I have to revise, etc.).

B.6. Information content quality

46. Lecture notes are the core learning materials on U-Link.
47. Course content and presentation gain attention.
48. Course content and presentation are long enough to cover all content.
49. The course content is covered to an appropriate degree of breadth.
50. The content is up-to-date.
51. I find it easy to understand and follow the content in lecture notes.
B.7. Service quality

61. Instructor's attitudes are good to learners.
62. Instructor's attitudes are friendly to learners.
63. Instructor is knowledgeable enough about content.
64. The service supported by the university is good enough.
65. I can contact with the instructor via mail or phone or fax.
66. I do not encounter any problems during communicating with university administration and help desk.
67. I do not experience any problems during registrations.
68. I can easily solve when I encounter a problem during admission to a module in registrations.

B.8. Supportive issues

69. U-Link lecture notes are prepared by obeying the ethical and legal issues.
70. The U-Link supported module provides any ethics policies that outline rules, regulations, guidelines, and prohibitions.
71. If the use of U-Link was optional, I would still prefer to use U-Link as a supportive tool as it helps my performance in the module.
72. If it was trendier and more popular, I would prefer to take this module totally online from home without having to come to the face-to-face lectures.
73. U-Link helps me to cut-down my expenditure such as paper cost, communication cost (i.e., phone), transportation cost, etc.

References


